PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE.

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VOL. XXXIX. JANUARY, 1900. No. 161.

Stated Meeting, January 5, 1900.

Vice-President SELLERS in the Chair.

Present, 20 members.

Messrs. Daniel Baugh, Leslie W. Miller, Henry Kraemer, Coleman Sellers, Jr., Edwin Swift Balch, Lindley M. Keasbey, Francis Rawle and Marion D. Learned, newly elected members, were presented to the Chair and took their seats in the Society.

Letters acknowledging election and accepting membership were read from Messrs. Edwin Swift Balch, Edward Coles, Coleman Sellers, Jr., Thomas Harvey Dougherty, Henry Kraemer, Alexander Jay Wurts, Albert Matthews, Lindley M. Keasbey, J. Rodman Paul, Daniel Baugh, Leslie W. Miller, Thomas Corwin Mendenhall, Otis Tufton Mason, J. Dundas Lippincott and Robert C. H. Brock.

The list of donations to the Library was presented and thanks were ordered therefor.

The decease of the following members was announced:

Dr. Elliott Coues, of Washington, D. C., at Baltimore, on December 25, 1899, in his 57th year.

Sir James Paget, Bart., of London, on December 30, 1899, aged 85 years.

Mr. A. Radcliffe Grote presented a paper entitled, "The Descent of the Pierids."

The Judges of the annual election for Officers and Council-

lors, held this day between the hours of two and five in the afternoon, reported that the following-named persons had been chosen according to the laws, regulations and ordinances of the Society to the offices for the ensuing year:

President.

Frederick Fraley.

Vice-Presidents.

Coleman Sellers, Isaac J. Wistar, George F. Barker.

Secretaries.

I. Minis Hays, Frederick Prime, Samuel P. Sadtler, Richard A. Cleemann.

Treasurer.

Horace Jayne.

Curators.

J. Cheston Morris, Benjamin Smith Lyman, Henry Pettit.

Councillors to serve for three years.

George R. Morehouse, Patterson DuBois, Henry C. Trumbull, C. L. Doolittle.

The Society was adjourned by the presiding officer.

THE DESCENT OF THE PIERIDS.

(Plates I-IV.)

BY A. RADCLIFFE GROTE, A.M.,

Vice-President of the American Association for the Advancement of Science, Etc.

(*Read January 5, 1900.*)

General Wing Characters of the Pierids.

A horde of bright butterflies with entire wings, simply marked in gay and contrasting colors: white, yellow, orange, red, brownish and black, rarely with a blue reflection or a lilac shade, but often marbled beneath with lichen green, of the most general distribution, and numbering almost all of the very few species of diurnals counted as injurious to vegetation. The neuration of the

Pierids may be best compared with that of the Limnadidæ among the brush-footed butterflies, but is most clearly more specialized. The cells are closed, but the transverse vein is often degenerate. There are still, sometimes, very small backward spurs, slight remainders of the vanished base of the median system. The cubital cross-vein has left no mark. The fork to the second anal vein of the fore wings at base is very thin and transparent. The trace of the first anal vein has usually disappeared. The upper median branches ascend the radius, in the specializing movement attending the disintegration of the system of the media. The radial branches are reduced at times to three, the usual number is four, and very rarely the five original branchlets are retained on the primary wing. On the hind wings the humeral cell is reduced, often the central slit can with difficulty be discerned, and sometimes the veins appear to be here completely fused and the subcostal to be single. The humeral spur is usually present, but vanishes in specialization. There are two anal veins on the secondaries. These characters show that the Pierids belong to the second division of the diurnals, in which the free and short downwardly curved third anal vein of the fore wings of the Papilonides is absent, viz., the Hesperiades.

An antecedent specialization has taken place on the hind wings in that the radius is single, or, if we adopt the view that it is furcate at base and that the costal cell is formed by R1, two branched. Present specialization seems still to favor the secondaries, as in those Nymphalids in which the cell is open on hind wings and closed on primaries, the reverse appears never to happen. But in the Parnassiidæ and the Pierids the progressing disintegration of the median system appears more marked now on the primaries, where the upper branches ascend the radius and the cross-vein weakens.

Phylogeny.

Not without much trouble have I been able to detach the terminal branch of the Hesperiades from what clings, and yet seems not to belong to it, on the lepidopterous tree. From a common pattern with separated veins, the middle branch of the disintegrating median system fading out at length (*in situ*) in both Blues and Skippers, owing to the shrinkage of the connecting cross-vein, the wings of the Lycænids have evidently emerged, losing the gen-

eralized Hesperian number of radial veins in the operation. The principal feature of the Lycænid-Hesperid offshoot is nearly realized by the next departure, that of the Nymphalids, in the "long-fork" of the Charaxinæ. Finally, we find the main branch itself culminating in the Pierids, which, while otherwise agreeing well with the brush-footed butterflies in neuration, are to-day nearly all relatively more specialized, the radius of the primary wings being usually only four-veined, the upper veinlets of the media tending also to travel up the vein and arise from beyond the cell. From this branch of the Hesperiades I have tried to disentangle the overlapping Papilionides, with their short, free and downwardly curved third anal vein on the fore wings, the second anal vein showing no thinner basal fork, as it does in the Hesperiades and most of the rest of the Lepidoptera. Even if, as appears to be Mr. Quail's opinion, I have not succeeded in getting rid of this Papilionid spray altogether, I have at least shown that its supposed issue from the Hesperiades branch, between the Blues and the Skippers, affords no growing point, the two latter being consecutive groups. And this was my main endeavor, to take *Papilio* out from between *Lycæna* and *Hesperia*.

And now having cleared as well as I am able the branch down to the Skippers or Hesperiadæ, let me try to get lower still and find the connection of the Pieri-Hesperiadæ with the trunk of the lepidopterous tree, the Tineides. And here I am met by an obstruction, and also a general prepossession out of which this obstruction arises. I will try to deal first with the prevalent assumption, which is, that the diurnals outrank the rest of the Lepidoptera, are more specialized, and that they represent, so to speak, the outcome of the evolution of the order, which has travailed long to produce them. This view is pictorially represented by all the genealogical trees I have seen, and we may take that of Dr. Packard (1895) as an example. Here the butterflies unfold themselves in the left-hand corner, at the top of the page, and the supporting twigs and limbs are supplied by all the moths, arranged more or less after the catalogue sequence, until we get down to the roots, represented by the Tineina and Eriocephalidæ. How it comes, after such a progression, that the pupæ of the diurnals still show Tineid features, as evidenced by Dr. Chapman, how it comes that the wings of butterflies retain generalized structures as I try to prove, seems, and no doubt is, incompatible with this perfect

scheme. Let us first take up the wings of some moths and show by comparison that they may be more specialized than those of the butterflies.

Specialization is shown by the different groups of the diurnals in a variety of ways and directions. It may be said of the Papilionides, that their main advance is in the reduction of the anal veins of hind wings and the hollowing out of the internal margin of the wing, as shown in an extreme degree by *Parnassius*. Now, when we examine the wings of the Saturnians, we see, in such genera as *Rothschildia*, *Samia* and *Callosamia*, the number of anal veins equally reduced to one, the internal margin equally hollowed out. It may be said again of the Pierids, that their main advance is shown by the diminution of the branches of the radius of the fore wings, which from five in number are reduced to four and three. Turning back to *Rothschildia*, *Samia*, *Attacus*, etc., we find the same reduction. It may be said in turn of the Nymphalids, that their main advance is shown by the opening of the discal cell, the more complete disintegration of the median system of neuration. Again in the same genera of Attacinæ, we find the cell even more completely open, the cross-vein vanished, the centre of the wing longitudinally clean from veins, the median system completely divided between and absorbed by the radius and cubitus (see my figures of Saturnian wings: *Beiträg zur Classification der Schmetterlinge*). Thus the wings of the single Attacid genus *Rothschildia* combine in a high degree the main features of the specializations shown separately by three most important groups of the diurnals. The Attacid wing is far more specialized than the wing of any butterfly. Not only this, it has also lost all residual features which are retained by the butterflies. Let us enumerate some of these: The backward spurs, traces of the base of the median system, to the discal cross-vein, present in many butterflies, are lost. All trace of the cubital cross-vein has vanished from the Attacid primary. This is strong in *Papilio* and allies, quite marked in a number of Nymphalid forms, Morphidæ, Limnadidæ, Heliconiidæ. On the hind wings, the humeral cell, formed by the forking of the radius, closed by the residuary vein R1, has also gone. This is found, in various stages of completeness, in many butterflies. The humeral spur (precostal spur) of the butterflies has disappeared in the Saturnians, while the frenulum has departed in both groups. If we take the specializations as indicating younger forms, then the

Attacid genera are more modern than the diurnals, which they thus clearly outrank. Now the indications of the base of the median system, the presence of cross-veins, the forking of the radius of hind wings, are primitive or Tineid characters, and the conclusion is here again irresistible, the diurnals are nearer to the Tineid trunk of the lepidopterous tree than the Attacinæ, because they retain more generalized features in the neuration. I think these considerations should divert the general prepossession that the butterflies are the final product of the lepidopterous tree, or that this corresponds in reality with Dr. Packard's plan, which, with all allowances, appears to be still governed by this idea.

The obstruction to proceeding further with the stem of the Hesperiades arises from that extensive group which Dr. Dyar has discussed under the name Bombycides (Agrotides), *Proc. Bost. Soc. N. H.*, 27, 127–147, 1896. I do not think sufficient attention has been paid to Dr. Dyar's separation of the higher moths into distinct phyletic groups upon the characters offered by the position of the larval tubercles. If these characters hold, and the groups established by Dr. Dyar are separate and monophyletic branches of the lepidopterous tree, an immense stride toward our comprehension of the order will have been made. The neuration offers, in the Sphingides, Saturniades, Bombycides, no exclusive character, nothing to absolutely limit these groups or to satisfactorily distinguish them from the Hesperiades. These latter are open to the moths generally, but, if Dr. Dyar's characters hold, I can now sweep aside this vast branch of the Bombycides and account for correspondencies by the fact that the branches have the same origin, but an independent and parallel growth. We need not pass through the Bombycides on the way to the root of the Hesperiades, nor could we very well, seeing they are now about equally specialized. In the same way we may neglect the Sphingides and Saturniades. Arriving in this way at the Tineides, we find in the Tortricidæ a family with partially concealed larvæ, in neuration and wing form having marked affinities with the Skippers. Beyond these are the related Cossidæ, with concealed, grublike larvæ, the neuration generalized in that the median system is complete. Both these families have the thinner basal loop to the second anal vein of primaries in common with other moths. While there may be no positive proof, it seems to me probable that these families of Tinei-

des have been developed from the same phyletic stem which finally produced the Pierids and Hesperiades.

If the alternative conclusion be adopted which I have suggested, that the so-called "precostal spur" is really homologous with the "humeral veins" of the Lachneids, we must seek for the origin of the Hesperiades in common with that branch of Dr. Dyar's Bombycides in which it is developed, and probably simultaneously from antecedent Tineid types. This would seem to weaken the probability, suggested by Sir George Hampson's phylogeny, that they are derived from forms which have not developed the structure, unless we assume the humeral spurs to be characters of convergence. This humeral vein, which I shall call in the progress of this paper the "humeral spur," is single in the Hesperiades, and may be here a survival, others having perhaps disappeared. This survival itself gradually fades away; in *Terias* it is a mere knob, in *Nathalis* it has nearly vanished.

The primitive Hesperiad had probably a wing in which the veins and branches were all separate, the base of the median system more or less fully developed and with the first anal existing. The second median was central. The cubital cross-vein was present. The fork of the second anal was possibly expanded into a longitudinal vein connecting with second anal by a cross-vein. The primitive Papilionid was probably propinquitous, having most features in common, but the third anal was longer and unconnected, and there are indications from the position of the second median that it was not central as in the primitive Hesperiad from the different shape of the discal cell. On the hind wings the primitive Hesperiad would have lost the three outer branches of the radius, but the first would be present, closing the subcostal cell as in the Sphingidæ. On the costal region of primaries the costal vein might have been functional, but it had probably already left the secondaries. Instead there might have been a greater development of humeral spurs.

It will accord best with the paleontological record if we assume an early and comparatively quick evolution for the diurnals, and as in these are included the Papilonides we must finally say a word as to their presumed origin.

I have recorded elsewhere my search for the short downwardly curved third anal vein of the Papilionides' primary wing. Mr. Meyrick having figured it in the Geometridæ, I sought for but

could not verify its existence. Indeed it is quite clear that Mr. Meyrick's figure of the wing of *Venilia macularia* is impossible. For supposing that we could homologize the loop of the second anal with the third anal of the Papilionides, Mr. Meyrick's figure would depict a moth with *four* anal veins to the primary, since both loop and downwardly curved vein are given. It seems as though the fork or loop to the second anal vein must exclude the third anal vein of the Papilionides and should therefore be homologous with it. In the Saturnian genera *Telea* and *Actias* the loop is continued as a short spur. This looks as though the loop might be the remains of a longitudinal third anal vein, which has been joined to the second anal by a cross-vein, while the external portion has afterwards degenerated.

This view is supported by the fact that the prolongations to the pure and simple loop appear in the Tineid families Cossidæ and Psychidæ, but, in either case, the diphyletism of the diurnals is untouched, since we can reach the *Cossidæ* without again meeting the free and downwardly curved third anal vein of the Papilionides. The third anal would have been merely connected with the second in one line and not in the other. At this moment the Papilionides hang in the air and their ancestry is undiscovered. We may suppose them to have been evolved at the same geological period with the Hesperiades, whose origin we can trace, and that the record has in their case become lost.

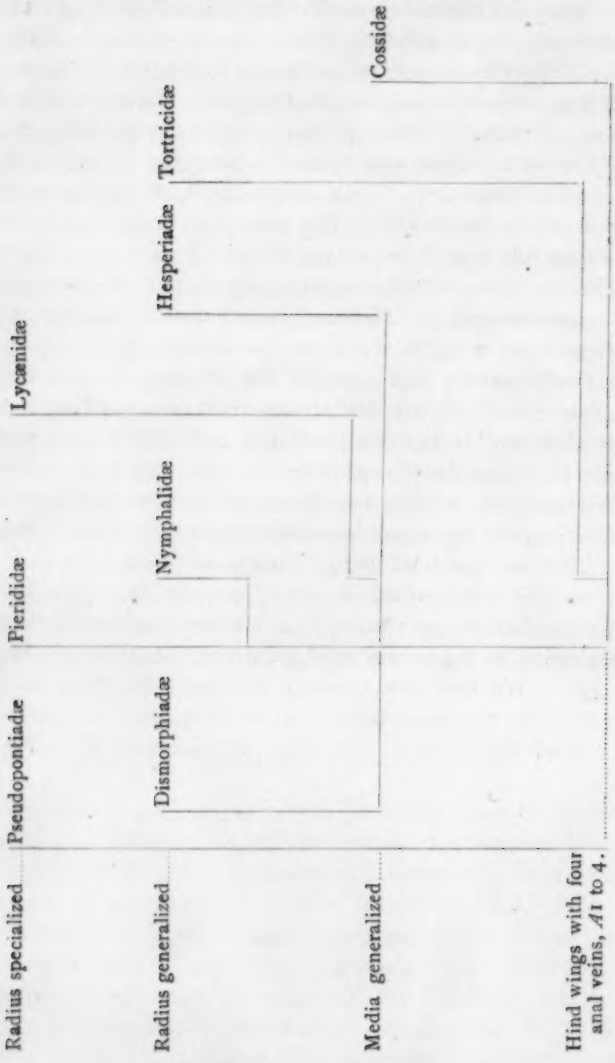
Aberrant Types.

Having thus indicated the course probably taken by the ancestors of the two divisions of the butterflies (Lepidoptera which of old loved light rather than darkness and hence may have become what they are), we can turn to a brief consideration of three dissonant minor groups which hang upon the skirts of the Pierids without any traceable connection. These are the Leptidianæ, the Dismorphianæ and what we must call the Pseudopontiadæ, for, according to a note in the *Entomologist's Record*, Mr. W. F. Kirby has shown that *Pseudopontia* of Plötz antedates by a little *Gonophlebia* of Felder, and Mr. Scudder's statement that we should prefer the latter is thus amended. The two former groups seem closely allied by the extraordinary character of the cubital movement of the middle vein of the median series. The Leptidianæ are pecu-

liar in the absence of the fork to the second anal vein of the fore wings. They are thus comparatively specialized, although the radius retains the five branchlets. The common characters of the two groups with their five-branched radius and elongate wings apparently warrant a phylogenetic association, though in their special features sufficiently distinct. The species are, technically speaking, "long wings," forms in which the primaries have the branches of the radius removed outwardly, sometimes, as here, entirely beyond the cross-vein of the discal cell. The passage of the ordinary broad-winged type into that of the "long wings" I have recorded in the Nymphalids. Since I find no connection here of the two types of wing I have separated the Dismorphiadæ from the Pierids, and exclude them when using in this paper the latter term.

The single species and type of the Pseudopontiadæ may be called, in contradistinction perhaps to almost all other Lepidoptera, a "round wing." In this place it is sufficient to state that the neuration is extraordinarily specialized. The radius is only three-branched and the median series shows the Pierid movement in specialization, the two upper branches both actually ascending the radius. But on the hind wings three anal veins have been preserved, and the origin of this isolated type must be sought for at a period when this structure prevailed. It may have survived in this instance owing to the necessity for sustaining the spherical shape of the wings. We may now connect this form directly with Tineides which have the same three anal veins on the hind wings present. Consult figure, PROC. AM. PHIL. SOC., xxxvii, Pl. I, Fig. 7.

PROBABLE PHYLOGENY OF THE HESPERIADES.



CLASSIFICATION.

The characters used in the following table are not exclusive, but serve to distinguish the material here discussed :

Hind wings with a single anal vein ..... .PAPILIONIDES.

Hind wings with two anal veins.....HESPERIADES.
Radius of fore wings 3 to 5 branched; first radial branch from above cell; *M*2 radial.....PIERIDIDÆ.
Radius of fore wings 5 branched; all radial branches arising beyond cell; *M*2 central or cubital....DISMORPHIADÆ.
Discal cells not reduced; the cross-vein concave; *M*2 cubital on fore wings.....*Dismorphianæ*.
Discal cells reduced; the cross-vein convex; *M*2 central on fore wings .....*Leptidianæ*.
Hind wings with three anal veins.....PSEUDOPONTIADÆ.

Family DISMORPHIADÆ.

Wings entire; fore wings with the radius 5 branched, all the short branchlets arising equidistantly beyond the cell. Cells closed; middle branch of the median series central or cubital. I find only doubtful traces of the fork to second anal vein of primaries at base. In the Dismorphianæ the male primary is narrow; hind wings sometimes much enlarged inferiorly; no trace of costal cell; middle branch of median series cubital; two anal veins.

Subfamily *Leptidianæ* Grote, 1897.

Wings entire, elongate, proportionate. Middle branch of median series central on primaries, cubital on hind wings. Cells closed, reduced to basal third of wings; cross-vein outwardly convex. No trace of fork to second anal on primaries. Secondaries not enlarged, proportionate.

Outer margin of fore wings acuminate between first and second median branchlets, second and third median propinquitous at base on cross-vein.....*Azalais*.
Outer margin of fore wings not acuminate; second and third median branchlets separate at base.....*Leptidia*.

Azalais n. g.

Type: *Leucophasia gigantea* Leech, *Ent.*, 23, 46, 1890.

Azalais gigantea.

A more specialized form than *Leptidia*, as shown by the approximation of the second and third median branchlets on hind wings, the two branches arising close together from the point of convexity of the cross-vein. This insect is described and figured in the *Butterflies of China*, p. 484, Pl. 36, Figs. 10, 11, 1893.

Gen. *Leptidia* Bilberg, 1820.

Type: L. sinapis.

Syn. *Leucophasia* Stephens, 1827.

Leptidia sinapis.

This common European species differs from *Azalais* by the characters given in the above table. From the neuration the genus *Leptosia*, with the type given by Scudder, does not belong here. In the *Handbook of British Lepidoptera*, Mr. Meyrick places *Leptidia* in the Pieridiдæ, between *Euchloe* and *Pieris*.

The wings of the Leptidianæ show apparently no sexual character in size and shape, whereas, in the Dismorphianæ, the males have the primaries narrowed and the secondaries disproportionately widened.

Subfamily *Dismorphianæ*.

This subfamily is closely related to the preceding, but differs by the sexual disproportion of the wings in the males of the genera allied to *Dismorphia*, and by the longer and narrow discal cells. I can find no traces of the fork to the second anal vein of fore wings at base except doubtfully in *Acmepteron*. The Dismorphianæ agree in the cubital position of the middle median branch, but this position is assumed on *both* wings, hence it would be herein a more specialized group than the Leptidianæ. The parallel between these two groups and the Heliconiidæ is shown by the neuration, in that the radial branches tend also in the latter family to arise beyond the cell. Neither in this group nor the Leptidianæ are there any traces of the cubital cross-vein, hence they are more specialized forms than the Heliconiidæ. It is possible the coincidences indicate that they had a common origin, but against this view the fact of the cubital position of the second median branch, as contrasted with its radial position in the Heliconiidæ and the brush-footed butterflies, will militate. The discal cross-vein is, however, concave on fore wings as in the Heliconians, but since it is convex outwardly in the Leptidianæ, which otherwise so well agree, the character will not have much weight. The broadened hind wings of male *Dismorphia* recall in shape those of *Pseudopontia*.

The Dismorphianæ are remarkable in the cubital position of the middle median branch of fore wings, and this position within the Hesperiades is only repeated apparently in certain Giant Skippers, Megathymidæ, which I have had no opportunity to study closely.

A trace of this tendency is, however, visible in the Skipper *Angiades sylvanus*. Here, on the fore wings, this vein, *M*2, still keeping central, has succeeded in sustaining its connection with the cubitus by a true vein; that is, the lower part of the cross-vein between *M*2 and *M*3 has retained its functional character, while the upper portion, between *M*2 and *M*1, has yielded to disintegration and become a scar. Hence *M*2 is still fed from the cubitus. On the hind wings vein *M*2 has failed to retain the connection, the source of blood supply has given out with the disintegration of the entire cross-vein, and, in consequence, this middle branch of the media has almost entirely vanished from the surface of the wing.

Of the genera of the Dismorphianæ, Mr. Scudder gives the type of *Dismorphia : laia;* of *Leptalis : astynome*. Additional genera are given by Dr. Dixey in a footnote, *Trans. Ent. Soc. London*, 1896, p. 65. Mr. W. F. Kirby kindly informs that the types of these are: of *Pseudopieris : nehemia;* of *Enantia : melite;* of *Moschoneura : methymna*. Of these types I have been unable to procure specimens of the first and last for study.

Gen. *Leptalis* Dalman, 1823.

Type: L. astynome.

Leptalis astynome.

Radius five-branched, all the branches arising beyond the cell; *R*1 fusing above with subcostal vein. Cell closed, long and narrow; cross-vein deeply concave, somewhat weakened. First median branchlet arising at junction of cross-vein with radius; *M*2 cubital. No trace of fork to second anal. Hind wings with hardly abbreviate somewhat pointed costal, curving toward base of wing; no trace of subcostal cell. First median branchlet has left cross-vein and arises from radius at about one-third of the length from cross-vein to external margin. Cell closed; *M*2 cubital.

This genus is, perhaps, less specialized than *Pseudopieris*, in which the discal cell is superiorly retreated, leaving *M*1 to spring from radius beyond it. It is more specialized than *Enantia* (to which it stands nearer) and *Acmepteron*, because in these the first median branchlet still remains on the cross-vein.

Leptalis melia.

I describe this since the species has become well known, owing to its having been cited by Fritz Müller as an example of the primi-

tive type of coloration of the genus. It is very close to *astynome*, but represents a slightly more generalized type and must be considered thus a more primitive form. It differs by the minute character that the first median branchlet appears as a continuation of the cross-vein from its upper corner; in *astynome* the fusion of the upper wall of the vein with the radius can be made out. The radial branchlets are a little longer, but R_1 equally fuses with the subcosta. On hind wings M_1 ascends the radius for a shorter distance, lagging thus behind *astynome* and much as in *Enantia*. Since I am not in a position to compare *Dismorphia*, I cannot conclude as to the absolutely right place for *melia* and leave it under *Leptalis*. Color and pattern do not move necessarily with neuration and at times (as in *Cunizza hirlanda*) are much at variance. *Leptalis melia* is a more specialized insect, so far as the neuration is concerned, than those forms of *Dismorphia*, now to be described, in which M_1 still clings to cross-vein before the upper angle of cell. From its position with regard to *astynome*, it might have served as a palette upon which the heliconine pattern of the wing was subsequently traced, but I think not, the differences in neuration being so very slightly to its disadvantage. The costal humeral spur of hind wings is as in *astynome*. *L. melia* appears as a natural specialization of *Enantia milete*.

I will first take up a form which stands a little apart from the others here treated of:

Gen. *Pseudopieris* God. and Salv.

Type: P. nehemia.

Pseudopieris nehemia (Boisd.).

Radius five-branched, all the branches arising beyond the cell. R_1 not fusing above with subcostal vein, but free. Discal cells closed, but curiously retreating superiorly on both wings; the cross-vein here falling back toward base of wings and leaving M_1 stranded and fused with radius, at a point opposite M_2, so that it has made no independent radial progress. On hind wings the humeral spur is straight, truncate, terminating in a Y-shaped projection.

This form differs from all others examined and the genus is undoubtedly valid, while the rest hold more or less together as phases in a progressive common specialization of the neuration.

Gen. *Enantia* Hübner, 1816.

Type: E. melite.

Enantia melite (L.).

Radius five-branched, all branches arising beyond cell, but compared with *Leptalis*, the first radial is less advanced, much nearer cross-vein, hence in a more generalized condition. *R*1, angulate, fusing with subcostal. Cell closed, concave; *M*1, from cross-vein close to radius; *M*2, cubital. Hind wings with hardly abbreviate, somewhat pointed costal, turning well to base of wing; no trace of subcostal cell. First median branchlet has left cross-vein and arises from radius at somewhat less than one-third of its length from cross-vein to external margin. Cell closed; *M*2 cubital.

This form is more generalized than *Leptalis*. Mr. Scudder takes *licinia* as the type of *Enantia*, but, for several reasons, I follow Mr. Kirby here.

Gen. *Acmepteron* God. and Salv.

Type: A. nemesis.

Acmepteron nemesis (Latr.).

Radius five-branched, all the branches arising beyond discal cell; *R*1 fusing with subcostal vein. Cell closed; cross-vein medially concave; *M*1 arising much before upper angle from cross-vein, hence this genus is more generalized than *Enantia*; *M*2, cubital; from the concave portion of cross-vein a strong backward spur arises, the relic of base of the median system. Hind wings with humeral spur straight, truncate; cell closed, with *M*1 arising at upper extremity of cross-vein, hence much generalized.

This genus comes nearest to the primitive type of the subfamily, being more generalized than any examined by me. There is a difference in the degree of sinuosity of the second anal vein, which is much bent in *Acmepteron*, but which I have not been able to precise. In this form also I believe to have detected a very faint linear scar at base of second anal, and which I cannot make out in the other genera of the family. It would occur naturally in a generalized form, but, as I have said elsewhere, the detection of the scar, when faded, is quite difficult and depends on the light in which the tegument is viewed.

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Conclusions on the Dismorphiadæ.

This small and peculiar family is of the utmost importance as bringing evidence of the solidarity of the Hesperiades as classified by me. The generalized features are distinctly those of the Skippers. The five-branched radius has the branches all equidistant, and they distinctly recall, in their position and course, the branches of the Lycænidæ and Hesperidæ. The radial branchlets have moved along; R_4 has crept up R_5 till it becomes a short fork. The cubital position of the second median branchlet shows the probability that the group, exhibiting a character which comes out in the *Megathymidæ*, and which is dormant in the Skippers proper, has left the main stem when this feature was in abeyance. That the forms are now relatively specialized is shown by the faded-out fork to the second anal of primaries. In specialization the branchlets of the radius have moved outwardly, keeping up their equidistant character. This is another link showing that the butterfly wing had originally separate veins and a five-branched radius. Relics of this type are afforded by the Charaxinæ in the Nymphalids. All these butterfly families converge, and the discovery of a comprehensive type would make easy what now must be pieced out with much care and thought. At present the butterflies are all greatly specialized, but the generalized characters are still there in fragments and can be put together. To these all the families contribute their quota. The Papilionides remain excluded, from their peculiarly placed third anal vein of the primary wing. As I have repeatedly said, granting the homology of the fork attached to second anal vein of the Hesperiades, with the short, downwardly curved third anal vein of the Papilionides, the diphyletism would be shown in the fact that the third anal has joined the second anal in the one case and remained free in the other. How important this is may be inferred from the fact that the first position is held unchanged to the Tineides through immense series of forms in all conceivable conditions of specialization, while that of the Papilionides is equally tenacious through a small group of genera of very diverse shape and appearance.

Family Pieridiдæ.

Wings entire, primaries broad trigonate, secondaries full, rounded, rarely with projections. Radius three to five-branched, cells closed, sometimes partially degenerate, again with slight backward projec-

tions, indicating the vanished base to the median system. The two upper branches of the median system ascending the lower side of the radius in specialization. (The second branch follows suit in *Phulia* as well as in *Pseudopontia*.) *M*2 radial. The fork to the second anal vein of primaries is usually, perhaps always, present, rigid, very thin and transparent. Hind wings with the subcostal cell lost, the subcostal vein solid at base; in some species, *e. g.*, *Hebomoia glaucippe*, there is a narrow slit perceivable. I have therefore assumed that all traces of *R*1 have generally disappeared and lettered the Subcosta S. alone; the fact that the radius is theoretically furcate at base has no practical value here. The humeral spur (precostal spur) is usually present; in some specialized forms, *e. g.*, *Nathalis*, *Colias*, it has vanished; in some subspecialized genera, *Eurema*, *Zerene*, *Phœbis*, it has left a slight projection. Discal cell of secondaries closed. *M*2 radial. Two anal veins. As compared with the Lycæni-Hesperiadæ branch, the neuration shows more complex changes, the relations more netlike.

No characters of the wings, or, in fact, other, have been found by me by which a subdivision of the Pieridídæ could be effected. Where there are no gaps there are no categories. The genera stand in various degrees of relationship toward each other; there is a tendency to form lines, culminating in a form with three radial branches, terminating in one with the generalized number five. I have indicated these lines in a former communication to the American Philosophical Society. The phylogenetic lines come out more clearly in the holarctic fauna; as we approach the tropics the increased number of forms render their separation quite difficult. I have no doubt I have often failed to give the true relationship; at least, I have tried to do this, to express by a lower position the fact that the form so placed displays here a neurational feature which a succeeding form has abandoned; this is in principle what is intended by phylogeny.

A rough division into "Whites" and "Yellows" from the prevailing colors of the wings has been attempted. Since these groups cannot be actually limited, they merit no Latin term. As often as I have tried to express their characteristics I have desisted, fearing to dwell upon exclusive marks. In *Pieris* and *Colias*, or *Eurymus*, we have a typical expression of the two associations, which are possibly really natural groups kept apart by general color.

Since the most specialized form I have found belongs to the im-

mediate line of the typical genus *Pieris*, I have commenced with the "Whites;" but since the lines probably really converge, it is not more correct than to begin with the "Yellows."

Typical "Whites."

(Pieridini.)

Gen. *Phulia* H.-S., 1867.

Type: P. nymphula.

Phulia nymphula. Staudinger, *Iris*, vii, Taf. i, Fig. 5 (neuration).

Radius three-branched; *R*1 and *R*2 before the cross-vein, *R*3–5 to costa just before apex. Only the lower median branchlet from cross-vein; *M*2 from lower side of radius not far from cross-vein; *M*3 a short furcation not far from apex. I cannot make out any trace of the fork to second anal; since this form is extraordinarily specialized by the ascension of the radius by *M*2 (paralleled in *Pseudopontia*), its absence might be expected, yet I have so often found traces of it in the Pieridiдæ where I thought it absent, that it may be finally detected here. Secondaries oblong ovate, humeral spur pronounced, turning to base of wing; first and second median together from upper angle of discal cell. No traces of subcostal cell.

From excellent figures of the neuration of species of *Phulia* given by Dr. Staudinger, *Iris*, vii, Taf. i, *Phulia nympha* Staud. would be slightly more generalized by the propinquity of *M*2 to the cross-vein (compare with Fig. 5 of *nymphula*). The species of *Phulia*, as well as the following *Trifurcula*, are Andean, flying at a height of 3000 to 5000 metres, department of La Paz, Bolivia.

Gen. *Trifurcula* Staud.

Type: T. huanaco.

Trifurcula huanaco. Staudinger, *Iris*, vii, Taf. i, Fig. 7 (neuration).

Radius four-branched; *R*2 advanced to opposite discal cross-vein; *R*3 a very short furcation. *M*1, ascending radius; *M*2 from cross-vein near to radius, so that the three veins are brought here close together, a feature which Staudinger considers characteristic. A very faint trace of fork to second anal. Hind wings shaped like *Phulia;* humeral spur straight, abbreviate; no trace of subcostal cell; *M*2 radial.

More specialized than *Pieris* by the advance of *R*2 to a point

opposite cross-vein; more generalized than *Phulia* by the four-branched radius and *M*2 still from cross-veins.

Gen. *Mancipium* Hübn., 1806.

Type: M. brassicæ.

Mancipium brassicæ. Grote, *Mitt. a. d. Roem. Mus.*, 8, Taf. i, Fig. 4 (neuration).

The validity of this genus seems to depend upon the fact, that in my preparations the short fork, *R*3 of *Pieris*, has disappeared. Dr. Chapman informs me that in material examined by him the veinlet still shows itself. *Mancipium* is then a *Pieris* with sometimes three-branched radius. It shows that there exists a tendency in *Pieris* to lose *R*3; the individuals not reproducing the vein are specialized, those repeating it relatively generalized. The genus stands on a very uncertain footing and should probably be dropped; it can only be used with any separate meaning for a part of the material of the typical species. *Pontia daplidice*, usually mixed with *Pieris*, may owe its similarity, I have ventured to urge, to convergence and belong really to the line Anthocharini. The generic title *Mancipium* covers the *Pieris* of the future, not of the present day, since any *Pieris* discarding the short veinlet *R*3 would become thereby equally entitled to be referred to it. From the neuration, I cannot distinguish *Pontia* from *Mancipium*.

Gen. *Pieris* Schrank, 1801.

Type: P. rapæ.

Pieris rapæ. Grote, *Mitt. a. d. Roem. Mus.*, 8, Taf. i, Fig. 5 (neuration).

Radius four-branched, *R*2 from above cell before cross-vein, *R*3 a very short fork before apices. Discal cross-vein shrunken; *M*1 from radius, *M*2 radial, quite close to upper angle of the cell. Fork to second anal at base distinct. Hind wings with humeral spur turned outwardly; no subcostal cell, but the vein seems to show a cleavage, its remnant. Discal cross-vein also medially deteriorate; *M*2 radial.

Pieris napi.

Agrees closely with the preceding, but the second radial is advanced nearer the cross-vein (emulating *Trifurcula*). The fork *R*3 is still shorter, quite minute and I should expect it to be occa-

sionally absent, when the specimen would be referable to *Mancipium*. *P. napi* is thus more specialized than *P. rapæ*.

We have thus come somewhat rapidly from local butterflies living on the heights of the Andes to the typical genus of the holarctic Pieridiдæ. It is clear from the retention of *R*2 above the discal cell, that the ancestors of *Phulia* have passed through the type of *Pieris*. *Trifurcula* seemingly represents an intermediate but lateral stage, in which *R*2 is advanced to opposite cross-vein, while *M*2 has not followed *M*1 and left the cell. The specializations are therefore probably independent and *Phulia* has not passed through a *Trifurcula* stage.

The genus *Pieris* represents an advanced type of the four-branched radius, on the verge of becoming three-branched, but one in which the second radial has retained its original position above the cell. This type may be used for comparison with the other genera, some of which have evidently attained, through convergence, the same condition; while on the passage of the five-branched to the three-branched form the stage of *Pieris* is more or less nearly repeated in different phyletic lines. For instance, in the "Yellows," *Callidryas* represents *Pieris*, with *R*2 still in position, but it falls behind in the long *R*3. *Zerene* abandons the original position of the second radial, which advances to opposite cross-vein and repeats the *Trifurcula* specialization. *Eurymus* (*Colias*) goes still further, *R*2 passing beyond the cell and the fork of *R*3 shortening to nearly the condition of *Pieris*. Thus we can probably use the type of *Pieris* with advantage to make the position of the other genera clearer.

Although *Phulia* has made an immense stride beyond *Pieris* toward a greater simplification of the neuration, as shown in the ascent of the radius by *M*2, in the short fork of *R*3–5 with *M*1 (through which we can imagine that the two may come to fall together), yet does *Phulia* remain on the *niveau* of *Pieris* by the retained position of *R*1 and *R*2. This fact illustrates the inequality of the specialization, in one and the same organ, of the characters we use as generic. This is a further amplification of that inequality of the specializations between the different stages of the insect to which I ventured to draw attention in 1875. It will then be impossible to "reconcile" generic groups founded on the separate specializations of larva, pupa or imago. Primary, *i. e.*, indifferent characters may be found, by which great groups can be

approximately outlined. But the characters used as generic are subject to constant modification and this from the total surrounding. And for larva, pupa and imago the *entourage* is quite distinct and as for different animals. It is this want of correspondence which shows itself upon occasion, together with the baffling features of convergence which makes the task of the zoölogist in unraveling phylogeny so extremely difficult. The classificatory strain put upon the features of specialization, as for instance by Dr. Karsch's system based upon the larval feet, or Dr. Dyar's foundation of the family Apatelidæ, is greater than they can bear.

My conclusion is, that, there being no homology between the specializations of the different stages in the Lepidoptera, there is also no correspondence.[1] It may be, in certain cases, that all three show marked specializations after their differing fashion, but there exists no necessity that they should do so. One specialization does not arise out of another. The very unusual larva of *Stauropus* produces a moth not so different from other Ptilodonts, as for instance *Heterocampa*. To revert to the genus *Apatela*, from which I drew my earliest deductions in this matter, if the curious clubbed or flattened hairs on the body of the caterpillar of *Jocheæra alni* and *funeralis*, were found instead on the body of the moth, our critic would reproach us with "ignorance" were we to overlook this generic character. A specialization is, however, a generic character, in whatever stage it presents itself, and in overlooking this in the larva our critic is himself at fault. *Jocheæra* cannot be thrown into the common pot of *Apatela* without covering over its peculiar specialization, and to do this is, to use for once a term I dislike, unscientific. A peculiar generic title simply means, that the insect possesses some peculiar feature, in whatever stage, that distinguishes it from its allies. There is, however, no test for the amount of the specialization necessary to support an independent title. To weigh the value of the categories, without prejudice, is the test of a capable classificator. I am not one of Mr. Butler's censors for his paper on *Apatela*, a paper both suggestive and challenging con-

[1] That variations in color in the preceding stages have no influence on the imago seems certain. From the two types of the pupa of *Papilio machaon* I have reared but one of the butterflies. Oscar Schultz separated aberratively colored larvæ of the same species, and they all produced normally marked and colored specimens. Aside from sexual peculiarities, there is then no necessary correspondence between the stages in this respect.

sideration, the more so since his critics do not seem to have been able to point out wherein his conclusions are really faulty. It is that Mr. Butler here mistook characters of convergence in the larvæ of *Apatela* for characters of affinity, and this we can control by a study of both moth and chrysalis. Furthermore, Mr. Butler placed a classificatory strain upon these characters, which they cannot carry, in giving them family value. Their value is generic, however much or little the moths agree; the conclusion is irresistible: we should use the larval specializations as the basis of generic names for the total cycle, if we are entitled so to use the specializations of the imago.

To continue our researches for generalized forms of the direct *Pieris* line, it is clear that we must confine ourselves to those in which the first two radials are in position above the cell, since the departure of *R*2 toward the tip of the wing is a further specialization which we can even conceive *Phulia* has yet to undergo.

Gen. *Huphina* Moore.

Type: H. coronis.

Huphina coronis.

Radius four-branched, *R*1 and *R*2 in position above cell, but as compared with *Pieris*, not so advanced along the vein. The neuration agrees with that of *rapæ*, but all the movements are retarded and show thus a preceding stage to that of *Pieris*. The fork of *R*3 with *R*4 and 5 is longer. The cells are closed; on primaries *M*1 ascends the radius for a shorter distance than in *Pieris*. On hind wings the humeral spur is pointed, turned outwardly. An antecedent stage of *Pieris*, which the latter has abandoned. The wings are of a similar texture with transparent veins.

Huphina judith.

Agrees with *coronis*, but slightly more specialized; *R*1 and *R*2 are nearer together, but *R*2 is further from the cross-vein than in *Pieris*. Wings more produced; the outline differing.

We now come to two genera which agree with the *Pieris* plan generally in neuration, but have produced primaries and light, bright colors and represent two stages in specialization wide apart.

Gen. *Tachyris* Wallace, 1867.

Type: T. nero.

Tachyris nero.

In the shape of the more pointed primary wings differing from *Pieris* and *Huphina*, the neuration agrees generally and the specialization seems to even exceed the latter. Radius four-branched; *R*1 and *R*2 nearer together than in *Huphina*; apical fork even shorter. Cell closed; *M*1 has ascended radius for about one-fourth of the distance from cell to margin; cross-vein between *M*2 and radius concave; a slight mesial backward spur. Hind wings with humeral spur turning sharply outwardly.

There are apparently four groups in this genus as established by Wallace, but I have only examined the type as given by Mr. Scudder (*Hist. Sketch*, 274).

Gen. *Hebomoia* Hübner, 1816.

Type: H. glaucippe.

Hebomoia glaucippe.

Agrees with *Tachyris*, but much more generalized, and there is a wide gap in the continuity which may be bridged over by forms to which I have not access.

Radius four-branched; *R*1 and *R*2 approached, but *R*2 well removed from cross-vein. Cells closed; *M*1 has not ascended the radius, as in the entire preceding series, but springs from cross-vein close to upper angle of discal cell. Traces of the base of media as in all generalized forms; two parallel creases can be made out, the upper joining to a slight backward spur at the origin of *M*2, the lower from a similar point at the centre between *M*2 and *M*3. First anal vein a very strong scar; this vein is only developed, however, incompletely in generalized forms. A strong fork to second anal at base. Hind wings with pointed humeral spur turned sharply outwards. Traces of a splitting of *S* at base, thus of a subcostal cell. Wings with transparent but strong veins.

This is the most generalized form which I can refer to the probable direct line of *Pieris;* it is a long way behind, from the fact that *M*1 lags upon the cross-vein. The line of *Pieris* seems to have connected with the *Aporia* line, which we now take up, and through forms like *Thestylis*, which may almost belong to either.

The neuration of *Hebomoia* is Pierid, not Anthocharid; the ornamentation of the wings above resembles on the other hand that of *Eroessa*, but also *Callosune*. I cannot see in the neuration any sure indication that it is related to the "Yellows." Probably all the generalized forms tend to meet, but I have found no comprehensive type in my material which might stand as ancestral to the whole.

A line which runs parallel with *Pieris*, and which is characterized by the opaque veins, strong wings, the two first radial branches in original position above the cell, the humeral spur of secondaries turned outwardly except in *Mesapia*, where it is truncate, and which possibly may connect with the main line through *Prioneris*, may now be taken up.

Gen. *Mesapia* Gray, 1856.

Type: M. peloria.

Mesapia peloria.

A miniature edition of *Aporia*. Veins strong, cells closed. R_2 more separate from R_1 and a very little nearer end of cell; the costal field above cell is wider on primaries, the cell a little more central than in *Aporia*. On secondaries humeral spur straight and truncate. Seems a slightly more specialized form than *Aporia*, with which it generally coincides even to the fraying of the cross-vein superiorly between M_2 and M_3 on fore wings. On the hind wings the veins appear more equidistant, M_1 is further removed from R than in *Aporia*. A rare form from Thibet.

Gen. *Aporia* Hübner, 1816.

Type: A. cratægi.

Aporia cratægi. Grote, *Mitt. a. d. Roem. Mus.*, 8, Taf. i, Fig. 6 (neuration).

Wings strong, entire veins opaque, cells closed. Radius four-branched; R_1 and R_2 in original position above cell, but R_2 removed a little outwardly. M_1 from radius, well removed from cross-vein; the branchlet R_3 longer than in *Pieris*. Second anal vein with a slender fork at base. Hind wings with humeral spur abbreviate, turned outwardly. A common European form.

Gen. *Metaporia* Butler, 1870.

Type: M. agathon.

Metaporia agathon.

Closely allied to *Aporia*, but the first and second radial branchlets are quite in original position, $R2$ further from the cross-vein, hence more generalized than *Aporia*. On hind wings humeral spur straight, truncated.

Dr. Staudinger catalogues under *Metaporia* a number of rare palæarctic forms which I have not been able to study, and which may not be congeneric with *agathon*, which the same author refers to *Pieris*.

Gen. *Prioneris* Wallace, 1867.

Type: P. thestylis.

Prioneris thestylis.

Wings ample, entire, veins opaque, tending to subtransparency. Radius four branched; $R1$ and $R2$ near together, well removed within cell, $R3$ a moderate fork. Cells closed; $M1$ ascends radius for about one-fourth of distance between cross-vein and external margin. Hind wings with humeral spur pointed, turned to apices of wing. Cross-vein, between $M2$ and cubitus, strongly convex with $M3$ nearly centrally placed, springing from apex of convexity; traces of a splitting of subcostal vein at base.

This genus is more generalized than *Metaporia* by the two first radial branchlets being less outwardly removed; the first median has ascended radius for a shorter space; on hind wings $M2$ is more central, continuous with cross-vein. It is more specialized than *Hobomoia*, by the ascent of radius by $M1$. On both wings $M2$ is continuous with upper portion of discal cross-vein, which latter, between $M2$ and $M3$, is slightly reduced.

We will now leave *Pieris* and its branch *Aporia* and seek for other parallel series of forms. The following line may not be continuous. I arrange the genera according to their grade of specialization.

Gen. *Elodina* Felder, 1865.

Type: E. egnatia.

Elodina egnatia.

Wings entire; radius specialized, three-branched; $R2$ has left the discal cell and progressed beyond the cross vein, being intermediate between $R1$ and $R3+4+5$, the latter a long fork with

*M*1, which ascends the radius to a little less than one-third of the distance between cross-vein and external margin. Cell closed, the vein a little degenerate, concave, *M*2 being thrown off from upper corner and apparently fuses with radius. A trace of fork to second anal. Hind wings with humeral spur straight, apparently turning outwardly at tip; subcostal vein solid at base; discal cell closed, cross-vein somewhat reduced.

A highly specialized form, as seen by the three-branched radius, the ascent by *M*1 of the radius and the position of *M*2 on the primary wing. The following represents a more generalized stage:

Gen. *Phrissura* Butler, 1871.

Type: P. ægis.

Phrissura ægis.

Wings entire; radius four-branched; *R*2 has not left the cell, but is advanced nearly to cross-vein; *R*3 a short furcation out of *R*4 + 5. Cell closed; *M*1 ascends radius; *M*2 radial, out of cross-vein which is concave between radius and *M*2. Trace of fork at base of second anal. Hind wing with humeral vein pointed, turning sharply toward apices.

This type very nearly assumes the stage of *Pieris* and stands much lower than *Elodina*. It is a little more specialized than *Pieris*, since *R*2 is nearer cross-vein, not quite assuming the position of *Trifurcula*.

Gen. *Ascia* Scopoli, 1777.

Type: A. monuste.

Ascia monuste.

This genus assumes almost completely, apparently by convergence, the *Pieris* stage. The four-branched radius shows the relative position of *R*1 and *R*2 as in *Pieris*. It is very slightly more generalized than *Pieris*, in that *M*2 is further from radius, not continuous with the short cross-vein between *M*2 and radius. Hind wings with humeral spur pointed, turning sharply, as in *Phrissura*, toward apices, not abbreviate as in *Pieris*.

Gen. *Mylothris* Hübner, 1816.

Type: M. rhodope.

Mylothris rhodope.

Wings ample, entire; radius four-branched; *R*1 and *R*2 in the *Pieris* position; fork of *R*3 with *R*4 + 5 longer than in

Pieris and *Ascia*, which agree, hence a little more generalized. *M*1 ascends radius; *M*2 in stage of *Ascia*. Trace of fork at base of second anal. Hind wings with humeral vein as in *Ascia*, pointed, turning sharply toward apex of wing.

There is probably a direct descent between *Mylothris* and the much more generalized *Nepheronia*. I interpolate, however, here the intermediate genus Ava, which, more generalized than *Mylothris*, probably connects with the *Ascia* line.

Gen. *Ava* de Nicéville, 1898.

Type: A. affinis (Voll.).

Ava affinis.

Wings ample, entire; radius four-branched; *R*1 and *R*2 in the Pierid position above cell; *R*3 a rather long fork out of *R*4 + 5. Cell closed; *M*1 ascends radius, perhaps for a little shorter distance than in *Ascia*, than which it would be thus more generalized; *M*2 is also a little further from radius than in *Ascia* and the cross-vein between them is concave or depressed, not straightly oblique. Trace of fork to second anal at base. Hind wings with humeral spur pointed, turning sharply toward apex of wing.

This genus is of the *Ascia* type, not of *Pieris*. As it is a little more generalized than *Mylothris*, I bring it in here. This is to be seen by the longer apical fork of *R*3; by the shorter stem of *M*1; the cross-vein between *M*2 is roundedly concave or depressed, not angulate as in *Mylothris*, and the second median standing a little further off from radius.

Gen. *Nepheronia* Butler, 1870.

Type: N. poppea (idotea).

Nepheronia poppea.

Wings ample; external margin a little retreating below apices; color and pattern of *Mylothris*. Radius five-branched, generalized, approaching the generalized form of the Anthocharid line; *R*1 and *R*2 in original position above cell; *R*3 and *R*4 near apices out of *R*5, comparatively short furcations. Cell closed; *M*1 does not ascend radius, but arises out of cross-vein just before radius; cross-vein angulate between *M*1 and *M*2, a little degenerate between *M*2 and *M*3. Hind wings with humeral spur curving gently toward apex of wing.

This form is the most generalized of the Pieridini of which I have any material. It stands below *Hebomoia* from the five-branched radius, but shows less residual features in other respects.

We now come to two genera (if really different) which appear to stand between *Hebomoia* and the present *Ascia* line.

Gen. *Callosune* Doubleday, 1847.

Type: C. danæ.

Callosune danæ.

Wings entire, form of *Elodina* and this approaches the latter by the shape of the discal cells which are somewhat broadened outwardly and short. Radius four-branched; $R1$ and $R2$ in original position above cell; $R3$ out of $R4 + 5$, a rather long furcation. Cell closed; $M1$ does not ascend radius, but fuses with it at upper angle of discal cell; $M2$ radial; cross-vein between $M2$ and 3 a little degenerate. Hind wings with humeral spur pointed, a little long and turning sharply toward apex of wing.

This and the following are more generalized forms than *Phrissura*, but appear to connect with the line *Elodina–Phrissura*.

Gen. *Anthopsyche* Wallengren, 1857.

Type: A. achine.

Anthopsyche achine.

Differs from *Callosune* only as follows: $R1$ and $R2$ a little more separate at base; $M1$ apparently more freely fused with radius; cross-vein between radius and $M2$ a little shorter; on hind wings the cross-vein meets the point of junction of $M1$ and $M2$, whereas in *Callosune* it meets $M2$ before the junction. By these points of difference it seems the more specialized form.

We now come to several isolated genera which I believe to be unequally related to the *Ascia* line or to some of its members as enumerated by me. No doubt more connection might be supplied by material inaccessible to me. They appear to me to be connected here rather than to the line *Pieris-Aporia*, strong-winged, more specialized forms, which I will afterwards consider before going on to the angled Whites.

Gen. *Melete* Swainson, 1832.

Type: M. limnoria.

Melete limnoria.

This is, I believe, the butterfly which Mr. Scudder calls "*Melete lycimnia* (*limnobia*)," *Hist. Sketch*, 215. I suppose "*limnobia*" to

be a misprint for *limnoria*. As I do not possess the means of fully checking this I thought I would be obliged to omit it at first, but I received the butterfly from Dr. Staudinger labeled "*Daptoneura limnoria*." According to Mr. Scudder, *Daptoneura* falls before *Melete*, with which it is synonymous.

Wings entire; apices produced; hind wings with anal angle roundedly produced; veins transparent. Radius of primaries four-branched; $R1$ and $R2$ in original position above cell, near together; $R3$ out of $R4 + 5$ a moderate furcation to apex. Cell closed; $M2$ ascends radius for a brief extent, about one-fifth of distance from external margin to cross-vein; $M2$ nearly central; two slight backward projections from cross-vein between $M2$ and radius. Hind wings with humeral spur straight truncated.

This butterfly is more generalized than *Mylothris*, more specialized than *Nepheronia*, which it appears to represent in the American fauna. The smooth wings are saturated with a pale yellow, deepening over the secondaries, the outer margin of which latter is bordered by a shade resembling the chrome yellow colored patches at base of primaries in its allies.

Two isolated genera, of differing grade of specialization, may be here considered. They have frail wings and in literature have been associated with *Leptidia* (*Leucophasia*), although the neuration does not appear to me to warrant the inference.

Gen. *Leptosia* Hübner, 1816.

Type: L. xiphia.

Leptosia xiphia.

Wings frail; discal cells developed, broadening outwardly, about two-thirds of length of wing. Radius three-branched; $R1$ from above discal cell; $R2$ advanced to opposite cross-vein, hence assuming the *Trifurcula* position; $R3$ to 5 furcating with $M1$ which ascends radius for about one-third of distance from cross-vein to external margin. $M2$ from upper corner of discal cell, apparently not quite fusing with radius; cross-vein concave. Hind wings with humeral spur appearing curved outwardly at top.

This genus is highly specialized, nearly on a par with *Elodina*. It is not related at all to *Leptidia*, and has more resemblance to *Neophasia*.

Gen. *Leucidia* Boisduval, 1847.

Type: L. elvina.

Leucidia elvina.

Wings frail, short, entire; discal cells wide, taking up about half of the length from base; radius four-branched; $R1$ in original position; $R2$ has advanced greatly, arising beyond cross-vein at about one-fourth of distance to external margin; $R3$ a short furcation with $R4 + 5$. Discal cell closed; $M2$ nearly central. Fork to second anal at base apparent. Hind wings with truncate straight humeral spur; $M1$ out of radius beyond cross-vein; $M2$ nearly central.

More generalized than *Leptosia* by the four-branched radius and equally unrelated to *Leptidia*. This species is very light yellow with dark apices of four wings.

Leucidia brephos.

This is one of the frailest of small butterflies; pure white, the neuration agreeing absolutely with the type, unless it is that the humeral spur is a little shorter, truncated.

This exhausts my material in the *Ascia* direction and we will now return to more specialized types of the line *Pieris-Aporia*.

Piccarda n. gen.

Type: P. eucharis Drury, sp.

Piccarda eucharis.

Wings ample. Radius three-branched; $R1$ from above cell in original position; $R2$ a short fork out of $R3$–5 before apices. Cell closed, vein between $M2$ and $M3$ hardly degenerate; $M2$ radial; $M1$ from lower side of radius, a little less than one-third of distance between cross-vein and external margin. Second anal with basal fork. Hind wings with hardly abbreviate, pointed, outwardly curved humeral spur; cell closed, vein a little more degenerate than on fore wings; Sc. apparently solid at base.

This genus differs from *Delias*, than which it is more specialized, by the position of $M1$, which is about one-third removed from discal cell.

Piccarda hyparethe Linné, sp.

Agrees with *eucharis*, the stem of $M1$ very slightly shorter, hence more generalized. There are probably other Asiatic species to be separated from *Delias* upon the above character.

Gen. *Delias* Hübn., 1816.

Type: D. egialea.

Delias egialea.

Radius three-branched; $R1$ from above cell in original position; $R2$ a short fork out of $R3$–5 before apices. Cell closed, vein between $M2$ and $M3$ somewhat degenerate; $M2$ radial; $M1$ from radius immediately beyond cell. Second anal with basal fork. Hind wings with pointed, outwardly curved humeral spur; cell closed, vein somewhat degenerate; Sc. apparently solid at base. Differs from *Piccarda* in the position of $M1$, which springs from radius quite close to the cross-vein beyond the cell, and hence is the more generalized form.

Gen. *Pereute* H.-S., 1867.

Type: P. callinice.

Pereute callinice.

Radius three-branched; $R1$ only from above the cell, but not in original position, being outwardly removed near to cross-vein; $R2$ a short sinuate branch anastomosing with $R1$ just before apices, thus a long supradiscal cell is formed, closed outwardly by $R2$. Cell closed, vein hardly or not degenerate; $M2$ central; $M1$ from radius about one-fourth of distance between cross-vein and external margin, herein resembling *Piccarda*. Second anal vein with thin fork at base. Hind wings with abbreviate humeral spur, not pointed, appearing turned to base of wing; cell closed, vein not degenerate; Sc. apparently solid at base.

This genus, except for the position of costal vein of secondaries, would appear as a lateral specialization of *Delias*. The fusion of $R2$ with $R1$ at tip of wing is so extraordinary that I should like to examine more material than is now accessible. Specialization is shown by the outward movement of $R1$ and $M1$. On the straighter and rather longer portion of the cross-vein between $M2$ and radius are too very slight inward projections showing where the vanished base of the median system joined on. In *Piccarda* and *Delias* these projections are barely indicated in the same places by a slight unevenness of the vein. This fact, among others, might show that the three genera are related, since in *Perhybris* there is only one projection in the middle of the shorter discoidal vein between $M2$ and the radius. In both this form and the more generalized

South American *Archontias* the costal vein of hind wings appears turned in the reverse position from *Delias*, and to the base of the wing. The correspondence, however, in the position of the radial nervules, between *Piccarda*, *Delias* and *Pereute* is very great, but is probably owing in the latter case to convergence. That the first radial does not attain the margin, but fuses with the short second radial, isolates *Pereute* from any other type examined.

Gen. *Archonias* Hübn., 1816.

Type: A. tereas.

Syn. *Euterpe* Swainson, 1832.

Archonias tereas.

Wings ample. Radius four-branched; $R1$ and $R2$ both moved forward, $R2$ opposite cross-vein; $R3$ straight, a moderate furcation to apex. Cell closed, vein between $M2$ and $M3$ medially degenerate; $M1$ from radius about one-fifth distance to external margin from cross-vein. Hind wings with humeral spur turned backwards to base of wing; Sc. appears to offer a line of cleavage; cell closed, vein between $M2$ and $M3$ thinner, but nowhere degenerate.

This genus and the following appear to represent the four-branched stage of the preceding *Pereute*.

Gen. *Catasticta* Butler, 1870.

Type: C. nimbice.

Catasticta nimbice.

The primaries are apically narrowed and produced, else this type agrees absolutely in neuration with that of *Archonias*, all the difference I note is that the stem of $M1$ is a little longer and that the discoidal vein, between $M2$ and radius, is quite even on the inner edge, losing the infinitesimal irregularity of *Archonias*. The produced apices seem to necessitate the wider fork between $R3$ and $R4$–5, while $R3$ is a little curved. How far these very slight characters are generic I cannot say without a larger material to examine.

We come now to a genus which shows affinities to the Anthocharids in the short terminal branches of the radius of fore wings, as well as in the truncated costal vein of secondaries, curving in one instance plainly to base of wing, and in the comparatively straight inner margin and determinate anal angle of the hind pair.

Gen. *Hesperocharis* Felder, 1862.

Type: H. erota.

Hesperocharis erota.

Wings ample; primaries with determinate apices and straight outer margin. Radius four-branched. *R*1 alone in original position above the cell; *R*2, 3 and 4 + 5 short branchlets near apex. Cell closed. *M*1 still from cross-vein. Secondaries with truncated humeral spur, nearly straight. Space between *M*2 and *M*3 wide, and here the discoidal vein is distinctly angulate superiorly. Anal angle determined.

This genus and its ally fall below the Anthocharids with four-branched radius, in that *M*1 has not ascended radius, but springs from cross-vein before upper angle of cell. I have corresponded with Mr. W. F. Kirby on the subject, who imforms me that he believes that *Hesperocharis* might well be subdivided. I find one type among my material which I venture to separate without being able to review all the described species described under *Hesperocharis*. *H. graphites* Bates, a very pale lemon-colored species from Mexico, agrees with the type of *Hesperocharis* in shape of wing, and, as far as I can see without preparing the wings, exactly in neuration.

Cunizza n. g.

Type: C. hirlanda.

Cunizza hirlanda.

Wings ample; primaries with rounded apices and outer margin sweeping inwardly. Neuration like *Hesperocharis;* terminal branchlets of the four-branched radius longer. Secondaries with space between *M*2 and *M*3 narrower, the cross-vein here shorter and not angulate. Humeral spur truncate, clearly turning to base of wing.

The principal distinction lies in the shape of the wings, which in this respect, color and ornamentation approach the line *Neophasia-Perrhybris*. The neuration is more generalized and entirely different from *Perrhybris pyrrha*, which it seems to copy.

Although, from the pattern, the temptation is to consider *Cunizza* a generalized *Perrhybris*, the markings of the former culminating in the latter, still it is not possible to bring *Cunizza hirlanda* into a relation with *Perrhybris pyrrha*, through the neuration. In *Perrhybris R*1 and *R*2 spring from the above discal cell, the Pierine

position; in *Cunizza*, as in *Hesperocharis*, only $R1$ remains in position (as in *Piccarda-Delias*), and $R2$ and $R3$ are short apical branches, succeeding each other out of $R4 + 5$, the Anthocharid type. The resemblances between *Cunizza* and *Hesperocharis* are too great to be set down to convergence, unless we had other characters. Again, the humeral spur sets toward the apex in *Perrhybris*, the Pierine position; in *Cunizza* it curves in the opposite direction, and this seems to be its trend in *Hesperocharis*, in which it is truncated. Alone the shape of the wings tend to remove *Cunizza* from the *Hesperocharis* and to bring it over to *Perrhybris*. Independent of the fact that the shape of the wings may be also influenced, the resemblance to *Perrhybris* is by no means exact. The apices are bluntly rounded, produced, in *Cunizza;* in *Perrhybris*, though rounded at apices, they bulge between $M2$ and $M3$, just where they retreat in *Cunizza*. The latter differs strongly from *Hesperocharis*, where the apices are squared and the external margin descends straightly.

A broken line, which may connect with the main line of *Pieris*, seems to be indicated by the North American Pine Tree White: *Neophasia menapia* Felder.[1] It is possible, also, that *Neophasia* is a generalized form of *Pyrrhybris*.

Gen. *Neophasia* Behr, 1869.

Type: N. menapia.

Neophasia menapia.

Wings somewhat elongated and shaped as in *Delias*, but frail in texture, and in this character resembling *Leptosia*. The *Pieris* type of neuration is nearly repeated. Radius four-branched; $R2$ moved forward, but not attaining cross-vein; the fork of $R3$ longer than in *Pieris*. Cell closed, the vein between $M2$ and $M3$ hardly degenerate; $M2$ radial; $M1$ ascending radius and leaving it about at one-third of total distance from tip of wing. Secondaries with humeral spur turned inwardly at tip, somewhat obscure and truncate; Sc. appearing undivided at base.

In the fact that the feature of *Pieris* is retained, that both $R1$

[1] Consult an article by R. H. Stretch, *Papilio*, 2, pp. 105 *et seq.*, for the habits of this insect. Through an apparent confusion of localities, the German lepidopterist Fruhstorfer thought he recognized, in a Pierid flying about meadows in the vicinity of Washington, D. C., this insect, which inhabits Washington Territory and Idaho. See *Insekten Borse*, Nov. 16, '99, p. 279.

and *R2* spring from radius before cross-vein, *Neophasia* agrees with the more specialized *Perrhybris*.

Gen. *Perrhybris* Hübn., 1816.

Type: P. pyrrha.

Perrhybris pyrrha.

Wings ample. Radius three-branched; *R1* and *R2* in original position above the discal cell; cell closed, upper half of vein between *M2* and *M3* shrunken, the shorter vein between *M2* and radius strong and showing a central backward projection, the remnant of the base of the median system. Second anal vein with a slender fork at base. Hind wings with humeral spur strongly turned outwardly; cell closed, vein between *M2* and *M3* somewhat shrunken; a single very slight backward projection on cross-vein between *M2* and radius; subcostal vein apparently solid at base.

The correspondence in the neuration between *Pyrrhybris* and *Mancipium* or *Pontia* may, I think, be due to convergence; otherwise we should have to regard the former as a specialized *Pieris*, of very strange pattern of ornamentation. The stage to which *Pyrrhybris* has attained in the reduction of the radius is anticipatory of *Delias*, but the relationship cannot be considered as direct or ancestral, since the reduction of the media is less advanced in *Delias*. If it were not for the existence of the latter genus, which is clearly ancestral to *Piccarda*, we might regard *Pyrrhybris* as a very early forerunner of the latter. As it is, the line *Piccarda-Delias* has probably emerged from the direct line of *Pieris*, from forms in which the median branches still kept to the cross-vein. The general directions in the reduction of the radial and median branches has been pointed out, and these studies now show the inequality in the rate of specialization between the two systems. In establishing phylogenetic lines we have to reckon with all the factors; in the present paper I am mainly endeavoring to show how the neurational features may be used, as well as the difficulties they present. I hope to have made it plain that their value is very great, but this will come out more clearly the more material is examined and compared.

In pattern of ornamentation *Pyrrhybris* is dimorphic, and the white color of the male above may be considered historically more recent and a specialization. But, in the veining, the sexes are

alike, hence there has been an independent advance in the pattern of the male.

An analagous difficulty with that in the case of *Pyrrhybris* and *Delias* prevents us from considering that *Neophasia* is related to *Cunizza;* since in *Neophasia* the media has progressed and not in *Cunizza*, where *M*1 still springs from the cross-vein. But it seems possible that *Pyrrhybris* may be looked upon as a specialization of a type similar to *Neophasia*.

The Angled Whites.

(*Anthocharini.*)

Of the group here discussed, all the types, from the three- to the five-branched form, are, if we admit *Pontia*, here extant, and the evolution of the specialized forms may have been relatively modern. The wings have somewhat sharp apices and often a perceptible sexual distinction in shape, the outer margin retreating in the males. The size is moderate, the ground color white, often with orange blotches in the male, the secondaries marbled beneath with lichen green. The specializations of the neuration run parallel with the *Pieris* branch; in one line the second radial branch remains in the original position, in the other it travels up the vein as it does in *Trifurcula*. The cells are closed; the transparent veins seldom degenerate. Humeral spur of secondaries turned toward base of wing or abbreviate and straight, except in *Pontia*.

Gen. *Pontia* Fabr., 1807.

Type: P. daplidice.

Pontia daplidice. Proc. Am. Phil. Soc., xxxvii, Pl. i, Fig. 1 (neuration).

A specialized form, with three-branched radius. I have discussed (*l. c.*, 35) what I believe has been hitherto overlooked, the fact that this butterfly possibly belongs to the present series, and that its resemblance to *Pieris* (than which it is more specialized) is mainly due to convergence. The second radial arises before the cross-vein, hence it would represent a culmination of the direct line from *Euchloe*. The humeral spur of secondaries turns outwardly as in *Pieris*, and this feature may ultimately prove me to be wrong.

With regard to the use of this generic title, Mr. Scudder says: "Curtis, *Brit. Ent.*, Pl. 48, designates (in 1824) *daplidice* as the

type, which must stand, although seldom used in this manner." (*Hist. Sketch*, 255.)

Gen. *Tetracharis* Grote, 1898.

Type: T. cethura Feld., sp.

Tetracharis cethura. PROC. AM. PHIL. SOC., xxxvii, Pl. i, Fig. 2 (neuration).

Radius four-branched; second radial branch arising before the cross-vein, although removed outwardly close to it. As this vein is shifting, it may be that this genus belongs on the other line as an antecedent, more generalized form to *Midea*. It is thus not an ideal link between *Euchloe* and *Pontia*, but it comes near to being one.

Gen. *Euchloe* Hübn., 1816.

Type: E. cardamines.

Euchloe cardamines. *Mitt. a. d. Roemer Mus.*, 8 Taf. ii, Fig. 9 (neuration).

Radius five-branched; second radial in original position. This is the generalized form of the group, with the second radial branch not removed outwardly toward the cross-vein. Hence it may represent an ancestral form of *Pontia daplidice*, with *Tetracharis* as possibly marking an intermediate four-branched stage.

Euchloe stella.

Radius five-branched; second radial in original position. As compared with *cardamines* it agrees in essentials. It differs in that the fork R_4 is a little shorter and that there is a trace of a backward spur on the short and here not oblique cross-vein between M_2 and radius. Else I can find no difference and conclude the forms to be congeneric.

We now come to the lateral line, in which the second radial has shifted to the *Trifurcula* position, opposite the cross-vein and then beyond it. I reverse here the order and commence with the most generalized form, comparable with *Euchloe*.

Before going further I wish to say a word upon the humeral spur (precostal spur) of secondaries or its remnant. The truncated humeral spur rises oftenest at right angles. It is then not always easy to say which way it tends, yet it shows an inclination to curve either way in special cases. Whether we can lay a strong determinative value on the directions we now perceive is to me doubtful.

In PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY, January, 1899, I have suggested that the humeral spur is homologous with the shoulder veins of the Lachneidæ.

Gen. *Anthocharis* Boisd., 1836.

Type: A. belemia.

Anthocharis belemia.

Radius five-branched; second radial arising opposite cross-vein in the *Trifurcula* position. R_4 a short furcation. M_1 from radius about one-third the distance from cross-vein to external margin. Humeral spur of hind wings continuous, pointed, turned to base of wing. Apices of primaries hardly produced and costa but slightly produced; external margin straight; anal angle of secondaries determinate. This genus is an advance on the *Euchloe* type by the attainment of the cross-vein by R_2.

Anthocharis belia.

Quite similar to *belemia*; R_2 has progressed a little beyond cross-vein, hence more specialized than *belemia*. Shape of wing the same.

Anthocharis ausonides. PROC. AM. PHIL. SOC., xxxvii, Pl. i. Fig. 4 (neuration).

Quite similar to *belia*, again R_2 seems a trifle advanced; R_4 still shorter, so that this form is the more specialized of the three. Shape of wing identical.

Gen. *Zegris* Rambur, 1836.

Type: Z. eupheme.

Zegris eupheme.

Radius five-branched; second radial well removed to beyond cross-vein, thus abandoning and passing beyond the *Trifurcula* position, which is assumed by *Anthocharis*. R_1 takes up nearly the original position of R_2. The apical portion of the wing is produced, and here the branches R_3, R_4, R_5 with M_1 are brought together; M_1 having ascended the radius for nearly half the distance between cross-vein and apices. The costa is strongly depressed; external margin even; anal angle of secondaries more softened than usual.

In the position of R_2 this genus is more specialized than *Anthocharis* or *Trifurcula*, but it falls behind the latter in which the

radius is only four branched. I have elsewhere discussed the resemblance between *Trifurcula* and the present line.

Gen. *Midea* H.-S., 1867.

Type: M. genutia.

Midea genutia.

Radius four-branched, hence more specialized than *Anthocharis-Zegris*, and with the second radial removed outwardly to very slightly beyond cross-vein, thus belonging to this series. Costa not depressed; apices acuminate between *M*1 and *M*2; external margin retired, sinuate; anal angle of secondaries hardly as prominent as in *Anthocharis*. *M*1 ascends radius for a little more than one-third of the distance from cross-vein to external margin.

This genus differs from the equally four-branched *Tetracharis* in the passing of the cross-vein by *R*2 as well as in the peculiar shaped primaries. I cannot admit the validity of the rule under which Mr. Scudder rejects this generic name. It is a limitation of the law of priority which is not recognized by all zoölogists, and is, I think, in itself indefensible.

I regret not to have had more species belonging to this group for examination. The series as arranged by me is not, as I have said, ideally perfect. It must be remembered that an existing type represents in some main feature a stage, standing between two others, which the higher genus has passed through and the lower commences to exhibit. After the type has been assumed, it will have further differentiated not only in the same direction, but, owing to the inequality of the specializations, in other directions which bring it out of focus. And the parent type has itself changed in the same way; perhaps we can even no longer recognize it as such, perhaps it has dropped away forever.

We now can turn to the generalized type of this series of "angled Whites," one which may stand for the parent of the two lines I have indicated and from the ancestors of which they may possibly have been thrown off. That we have to go to Chili for this type may possibly seem strange, and it may be there is a progenitor or its representative nearer home which I have not discovered, but the question of distribution is so far-reaching and so little is safely known as to its action and causes that I cannot here enter at all upon it. I must take the types where I find them.

Gen. *Eroessa* Doubleday, 1847.

Type: E. chilensis.

Eroessa chilensis.

Radius five-branched; second radial in original position above the cell. The first median branchlet has not ascended the radius, but is thrown off from the discal cross-vein. Hence this form is more generalized than all the preceding. It represents quite surely an ancestral form of *Euchloe*, in which latter *M*1 ascends radius. Cells closed; second anal of fore wings sinuate; fork present. Humeral spur of hind wings abbreviate. Outer margin of wings uneven, slightly scalloped. The plan of neuration accords with the Anthocharid type. On the whole this is one of the most generalized Pierids I have met with.

In this group the humeral spur of secondaries is shortened and straight in all the forms examined except *Anthocharis belemia* and *A. ansonides*, in which it appears as if curved backwards to base of wing, and *Pontia daplidice*, in which it appears curved in the reverse direction, toward the apex of the wing, and this is the direction of *Pieris*, *Delias*, etc. This makes my reference of *Pontia* to this series doubtful. In any event, *daplidice* is the type of a distinct and more specialized genus than *Pieris*. It must be confessed that it is hardly possible to separate it neurationally from the *Mancipium* three-branched type. Alone the contour of the wing is Anthocharid; there is a slight sexual difference in the primaries, the male wing seeming a little narrower and the anal angle of hind wings is more determinate than in *Pieris*. The ornamentation is Anthocharid. I leave *Pontia* here to draw attention to it. It would, indeed, make the group here discussed more homogeneous were we to transfer *Pontia* to the typical Pierid series; the types would be more of a size. Again, in *Phulia*, the costal vein of hind wings is turned to base of wing, the Anthocharid direction, while in *Trifurcula* it is truncate or abbreviate, straight, as it is in many Anthocharids. In both genera the shape of the wings and ornamentation are Pierid rather than Anthocharid, but this is more clearly the case with *Phulia*.

The "Yellows."

There are apparently two lines, as indicated by me in Proc. Am. Phil. Soc., January 1898, p. 38. In the non-typical line the wings are proportionately wide and frail, with less accentuated

angles, which, in a branch of the typical line, become unusually prominent, more so than in the angled Whites. No characters have been found to separate these lines, which possibly interlace. The antennæ seem relatively shorter, the thorax more pilose and the body stouter in the typical line, but these distinctions are relative and cannot be controlled.

Non-typical Yellows.

(Euremini.)

Gen. *Nathalis* Boisduval, 1836.

Type: N. iole.

Nathalis iole. Grote, PROC. AM. PHIL. SOC., xxxvii, Pl. i, Fig. 5 (neuration).

Wings entire; radius three-branched; *R*1 in original position; *R*2 advanced outwardly to extremely near cross-vein, hence the *Trifurcula* position is practically assumed. Discal cells on both wings broadening outwardly; *M*1 ascending radius outside of discal cell for a space a little less than one-third of the distance to external margin. On fore wings *M*2 is nearly central, on hind wings radial. A trace of fork to second anal on primaries. On secondaries the humeral spur has vanished, leaving the outer edge of the vein simply a little uneven or jagged. This is the most advanced form and a specialization of *Eurema.* In my figure, otherwise quite exact, the slightly jagged edge to subcostal is not, it hardly can be, rendered.

Gen. *Eurema* Hübner, 1816.

Type: E. delia.

Eurema delia.

Wings entire; radius four-branched; *R*1 in original position; *R*2 advanced, but much further from cross-vein than in *Nathalis; R*3 a rather long furcation out of *R*4 + 5. *M*1 ascending radius but not so far as in *Nathalis; M*2 nearly central on both wings. On secondaries the humeral spur has vanished leaving the vein apparently a trifle more jagged than in *Nathalis.* The cross-vein joins *M*1 on hind wings, whereas in *Nathalis* it nearly meets, as on primaries, the radius.

If anything were needed to prove the reality of the successional movements in specialization of the veins on the butterfly's wing, as

brought out in my writings, a comparison of these two types would remove it. *Eurema* represents a stage which *Nathalis* has abandoned in all the above particulars.

Gen. *Terias* Swainson, 1820.

Type: T. hecabe.

Terias hecabe. Grote, Proc. Am. Phil. Soc., Vol. xxxvii, Pl. i, Fig. 6 (neuration).

The wings are more ample, longer than in *Eurema*, but the neuration agrees so closely that I cannot precise any differences. It has seemed to me, by infinitesimal points, as less specialized; but it marks no new phase in the movements of the veins. The genus appears of very doubtful necessity and can be omitted from a table.

Gen. *Xanthidia* Boisduval, 1829.

Type: X. nicippe.

Xanthidia nicippe.

But if the necessity of *Terias* is doubtful, there seems too little for the retention of the present type, which agrees in the more ample wings with *Terias*. All the positions of the veins are maintained. I find only a slight variation in the discal cross-veins; on the hind wings of *Xanthidia* the latter run more obliquely outward superiorly, more continuously with *M2*; on the fore wings, the inward bulging is slightly less pronounced. It seems a good deal like trifling to consider this a distinct genus and I can make no use of it. See Mr. Scudder's remark, *l. c.*, p. 288. I have been unable to secure a specimen of *Abœis cebrene* for comparison.

Gen. *Sphænogona* Butler, 1870.

Type: S. bogotana.

Sphænogona mexicana.

I have neither *bogotana*, which Mr. Kirby considers type, nor *ectriva*, so given by Mr. Scudder. Mr. Kirby writes that *bogotana* quite agrees with my species and I can readily believe it. The neuration is practically identical with that of *Eurema* or *Terias;* again the cross-vein of secondaries is a little less bulging, straighter. The only distinction upon which to found the use of a separate name, is that the hind wings are produced or angulate on external

margin, on the interspace just below *C*1. Color and pattern are not distinctive, but virtually agree in all these forms.

The preceding types are all, except *Nathalis*, too closely allied to be generic, and they all agree in one important point, the reduction of the humeral spur. The marks of a former presence of the spur are to be seen on the shoulder of the subcostal vein, slight, jagged protuberances. These are so obscure and so similar in all the cases, that it is hardly possible to draw any distinction, and my impression, that they are less noticeable in *Nathalis*, may be after all incorrect. But it is of no obvious importance; the main fact being that the spur has vanished in all these types. That *Eurema*, *Terias*, *Xanthidia* and *Sphænogona* should agree in this is not extraordinary, since the neuration is otherwise so similar in all these forms, that their generic separation seems quite unnecessary. Nor are there any other characters, so far as I am able to see, which would authorize us to consider them as types of different genera, and only in *Sphænogona* have we the angulation of external margin of secondaries to sustain a separate title. But that *Nathalis* should not differ, leads to the inference that the reduction of the radial branches may have happened after the loss of the humeral spur. The disappearance of the branchlet suddenly, however, is contradicted by the mass of instances in which the evidence is clear, that the absorption takes place slowly. The stages of progression of the branches along the radius are constantly marked in a variety of forms, in which we find them but slightly differing in relative position. And when *R*2 finally leaves its original place above the cell, where *R*1 remains, the inference is plainly that it gradually moves along toward the tip of the wing. We see it in fact advancing by consecutive stages to the cross-vein, there assuming the *Trifurcula* position, and then, traveling still onward, gradually approaching the apices of the primaries. All this shifting, which we can now follow, by studying the different stages in different types, must be assumed to reflect the action which has formerly exhausted itself on the radius of secondaries, and of which only fragmentary direct evidence remains in the five-branched radius of *Hepialus*, the Micropterygides, and a late stage of reduction in *Crinopteryx familiella*. After all admissions, that in certain cases the present reduction on the primaries may be relatively rapid, the very multiplicity of the existing stages is evidence that in general it is being slowly accomplished. The movement has been going on

since butterflies were butterflies, whose story is forever in the changes of their wings.

The following two genera represent generalized types as compared with the preceding, $R2$ being in original position.

Gen. *Ixias* Hübner, 1816.

Type: I. pyrene.

Ixias pyrene.

Radius four-branched; $R1$ and $R2$ arising above cell; $R3$ a moderate fork out of $R4 + 5$. Discal cell closed. $M1$ ascending radius for a short distance beyond cross-vein; $M2$ radial. Second anal sinuate with a strong fork at base. Hind wings with humeral spur pointed, turned to apex of wing; lower portion of discal cross-vein weaker, joining $M2$, which appears continuous.

More specialized than the allied *Idmais* and *Teracolus* by $M1$ being further removed from cross-vein out of radius. The genus may not be correctly placed, but would fall in here from the stage of specialization.

Gen. *Eronia* Hübner, 1822.

Type: E. cleodora.

Eronia cleodora.

Radius five-branched; $R1$ and $R2$ in original position above cell; $R3$, 4 and 5 near together before apices. Discal cell closed; $M1$ not ascending radius, but leaving at upper angle of cell. Hind wings with humeral spur pointed, turning to apex of wing; discal cross-vein joining $M2$.

I have little doubt that this generalized type with five-branched radius represents an ancestral phase of *Eurema* and allies.

Typical "Yellows."

(Eurymini.)

As formerly pointed out by me, there seem to be two terminal lines, which appear to fuse and are probably also connected with the Euremini.

Gen. *Eurymus* Swainson, 1829.

Type: E. hyale.

Eurymus hyale. *Mitt. a. d. Roem. Mus.*, 8, Taf. ii, Fig. 7 (neuration).

Radius four-branched; $R2$ has abandoned its original position and advanced along radius to considerably beyond cross-vein.

Discal cell closed; *M*1 has ascended radius for nearly a third of the distance between cross-vein and external margin; *M*2 strongly radial. On hind wings the humeral spur has entirely vanished and seems to have left no traces; *M*2 from cross-vein.

This is a specialized form from the above characters. Its ally, *E. edusa*, is figured PROC. AMER. PHILOS. SOC., xxxvii, Pl. ii, Fig. 8, and the neuration discussed. This genus is known in literature as *Colias;* I follow Mr. Scudder in retaining *Colias* for the type *C. rhamni.*

Gen. *Zerene* Hübner, 1816.

Type: Z. cæsonia.

= *Meganostoma* Reakirt, 1863.

Zerene cæsonia. PROC. AMER. PHILOS. SOC., xxxvii, Pl. ii, Fig. 9 (neuration).

This type can be used as representing a close antecedent stage of *Eurymus*, one through which *Eurymus* has passed. The dog's head pattern is then a generalization of the pattern of *Eurymus*, and this would be borne out by *Idmais*, in which it is yet more developed and which represents a still earlier phase of these two genera. The second radial branch stops at the cross-vein in *Zerene*, assuming the *Trifurcula* position. On hind wings a fragment of the humeral spur remains, the tip being worn away.

I formerly referred *Zerene* as = *Colias* Auct. nec Fab., which seems to have been indeed Hübner's intention, who, however, also included this type (*cæsonia*). Mr. Scudder has corrected me (*Historical Sketch*, 213).

The preceding types show *R*2 in a state of flux. In the following it retains its original position above the cell and the types are accordingly more generalized. I have my doubts whether a linear succession here displays their true affinities, but they are at least correctly placed with regard to the degree of specialization of the wings.

Gen. *Teracolus* Swainson, 1832.

Type: T. subfasciatus.

Teracolus subfasciatus.

Primaries with sharp apices; radius four-branched; *R*1 and *R*2 in original position above cell; *R*3 a moderate furcation out of *R*4 + 5 to tip of wing. Discal cell closed; *M*1 out of radius just

beyond upper angle of the cell. Second anal with distinct fork at base. Hind wings with humeral spur pointed, turning toward apices.

This genus is generalized by the fact that *M*1 has not ascended radius for any distance beyond cross-vein, and that *R*2 is in original position. It agrees in these characters with the following. It is peculiar by the sharp apices. On both wings the discal cross-vein between *M*2 and *M*3 is somewhat weakened and *M*2 appears continuous in consequence. I can see no indication that the genus is Anthocharid, as assumed by Reuter.

Gen. *Idmais* Boisduval, 1836.

Type: I. chrysonome.

Idmais vesta.

I have been unable to obtain the type. The present species shows a form quite agreeing with *Teracolus*, differing only that the lower part of the cross-vein on secondaries joins the point where *M*1 and *M*2 furcate; this position of the cross-vein in *Teracolus* joins *M*2 beyond the furcation. Hind wings with humeral spur as in *Teracolus*. Both these genera are more generalized than *Eurymus* (Colias) by the well-developed humeral spur, the second radial not advanced, *M*1 not ascending radius. They may thus be regarded as ancestral types of *Eurymus*.

This genus may be regarded as more specialized than *Teracolus*, on account of the disposition of the discal cross-vein.

We may now turn to the line in which the wings are angulated and of an unusual, somewhat leaflike shape, in which the agency of mimicry has been suspected.

Gen. *Colias* Fabricius, 1807.

Type: C. rhamni.

Colias rhamni. Mitt. a. d. Roem. Mus., 8, Taf. ii, Fig. 8 (neuration).

The costal region above the cell is wider than usual and the subcostal and radial branches are somewhat bent upwards to sustain it. Radius four-branched; *R*1 and *R*2 apparently in original position above the cell, a little further apart than usual. *M*1 ascends radius for but a brief space; *M*2 radial. Second anal with a strong fork at base. Hind wings with humeral spur vanished; dis-

cal cross-vein medially degenerate, joining *M*2 immediately beyond the furcation of *M*2 with *M*3. This species, with sickle-shaped outer margin of primaries and pointed apices between *R*4 + 5 and *M*1, with also angulate secondaries at *C*1, is more specialized than *Rhodocera*, and lags behind *Amynthia* in the position of *R*2. Since I use the type for comparison I describe it first; on the whole it seems the more specialized genus.

The generic terms *Gonepteryx* Leach, 1815, and *Earina* Speyer, 1839, are considered by Mr. Scudder as synonymous with *Colias* Fab., nec Auct., as also *Gonoptera* Dalman, in Billberg, 1820.

Gen. *Amynthia* Swainson, 1832.

Type: A. mærula.

Amynthia mærula.

This type shows a stage in which *R*2 has progressed further along radius than in *Colias*, stopping but little before cross-vein. On the other hand there are jagged points showing the trace of the humeral spur, which I do not see in *Colias*, and the position of *M*2 on secondaries is more central from cross-vein and more generalized, being as in *Rhodocera*. The specializations are, as I have constantly stated, unequal. The apices of fore wings are less sharp in *Amnythia*, which, aside from the movement of *R*2, is more generalized than *Colias*.

Gen. *Rhodocera* Boisduval, 1829.

Type: R. menippe.

Rhodocera menippe.

This form differs from the preceding in the absence of angulation to hind wings and the blunt primaries, with external margin, but little depressed. It is the more primitive of the three forms, agreeing with *Amynthia* in the position of *M*2 and approaching *Colias* in the position of *R*2. It is more generalized than either in the fact that the base of the humeral spur still remains. This large butterfly represents a stage which both *Colias* and *Amynthia* have, in varying degrees, abandoned.

We will now take up an angulate type, which is more specialized than *Rhodocera*, which it resembles in shape of primaries, and intermediate between *Colias* and *Amynthia* in position of *M*2.

Gen. *Dercas* Boisduval, 1847.

Type: D. verhuellii.

Dercas verhuellii.

Primaries blunt, external margin uneven; not depressed; secondaries angulated just beyond M_3. Texture of the wings frail as compared with *Colias* and allies. Radius four-branched; R_2 has advanced to almost exactly opposite cross-vein, thus the *Trifurcular* position is very nearly assumed. Else the venation is much as in *Amynthia*, M_2 a little more radial. Hind wings, with humeral spur developed, but feeble, pointed, curving a little to base of wing.

This form has evidently the same parentage as the preceding, but represents a slightly differing type of wing.

We now arrive at three types, which are really too close to be of much interest to the classification, and which stand in the relation of ancestral forms to the foregoing modified types with angulate, leaf-shaped wings. I take the genera in the order of priority.

Gen. *Catopsilia* Hübner, 1816.

Type: C. crocale.

Catopsilia crocale.

Wings entire; radius four-branched; R_2 advanced almost to opposite cross-vein, not quite so near as in *Dercas*. Discal cell closed; M_1 from radius, about as far advanced along the vein as in preceding genera; M_2 from cross-vein, radial, nearly in the position of preceding genera. Second anal with fork at base. The humeral spur is present as a basal fragment.

This series shows the progression of M_1 up the radius, in *Catopsilia* the most advanced. The genera on the whole lag behind the preceding, not only in the non-angulate, normally shaped wings, but as affording evidence that the *Colias* types have sprung from such forms in the retarded characters of the venation.

Gen. *Phœbis* Hübner, 1816.

Type: P. argante.

Phœbis argante.

As compared with *Catopsilia* the ascent of M_1 up the radius is retarded; the fork of R_3 with $R_4 + 5$ is somewhat longer, all characters of comparative generalization. In fact these three types

only represent unequal stages in the normal course of specialization, preserving an identity of general character which renders the idea of different genera difficult. It must be also borne in mind that all the species have not been compared, and the chances seem to be that among a number of forms agreeing so well externally, similar characters to those here used will occur, still further increasing the number of genera.

In the comparative length of the fork $R3$ with $R4 + 5$ the genus *Catopsilia* is the more specialized.

Gen. *Callidryas* Boisduval and Le Conte, 1829.

Type: C. eubule.

Callidryas eubule. PROC. AM. PHIL. SOC., Vol. xxxvii, Pl. ii, Fig. 10 (neuration).

$R2$ has strayed still further from cross-vein than in the two preceding types. The fork of $R3$ with $R4 + 5$ is much as in *Phœbis;* on the other hand $M1$ has progressed further up the vein, intermediate in position between *Catopsilia* and *Phœbis.* Perhaps this type is really intermediate, although the view that it is the more generalized is tenable. The base of the humeral spur is developed as in *Phœbis,* which latter may more nearly represent the type from which the others and the whole Eurymini have sprung.

We now come to what appears to be a lateral specialization of *Catopsilia* or *Phœbis.*

Gen. *Parura* Kirby, 1896.

Type: P. cipris Fab. nec Cramer.

= *Metura* Butler, 1873, preoccupied.

Parura cipris.

Differs from the types included under *Catopsilia* by the hind wings being strongly produced at anal angle. The condition of the shifting branches nearly reproduces the condition of *Phœbis.* The humeral spur is incomplete.

I have now exhausted my material of the types of genera in the Pierids. It has been sufficiently extensive, I hope, to have allowed me to sketch the group and to lay down for the first time some safe conclusions upon the neuration. That more remains to be done I am fully aware, nor do I insist upon minor points, liable to be modified from greater material. I have wished mainly to supply a neurational basis for the generic types examined and as a general rule

have abstained from interfering in the question of the necessity for generic titles.

Movement of the Veins in the Wings of the Pierididæ.

The movable veins of the primary wing are the branchlets of the radius and media. The generalized type has five branchlets to the radius, two arising above the discal cell, the remainder beyond the cross-vein. The diminution by specialization of the branchlets is effected by their outward movement, and they appear to pass off by the external margin of the wing. It is especially the movement of the second radial branchlet which gives rise to interesting combinations. Sometimes the outer branchlets disappear, leaving a single vein, and the second radial remains still in position, as in *Pontia*. Again the second radial commences its travels along the upper side of the vein, stopping at various points along the route, before the terminal branchlets have been disposed of, as in *Anthocharis*. Arrived at the point opposite the cross-vein, it gives the *Trifurcula* position, as I have called it in this paper, in which the second radial, then the main vein of the radius from which it ascends, and finally the cross-vein, running in an opposed downward direction, meeting, give the appearance of a trident. This position of R_2 is not confined to *Trifurcula;* it always recurs and must recur in the progress of the second radial branchlet along the vein, and in fact is exhibited now by a number of genera. Also in genera, like *Piccarda*, *Delias*, *Perrhybris*, in which the second radial has long passed the cross-vein by, the ancestors must have exhibited the *Trifurcula* position at some time in their history, when their second radial branchlet attained this point, and for the moment retained it. In the Pierididæ the first radial always keeps its position above the cell.

The generalized type, so far as the media is concerned, has the three branchlets all springing from the cross-vein, the second medial having a central position. This is soon abandoned in specialization and the branchlet approaches the radius, while the cross-vein, in the widening space between M_2 and M_3, become somewhat worn, the first sign of the ultimate breaking up of the median system through the opening of the discal cell. In the meantime the first median branchlet leaves the cross-vein and ascends the radius on its lower side. Only in such extreme cases of specialization as

Phulia and *Pseudopontia* does the second median branchlet follow this example. Meanwhile the third median attaches itself to the cubital system. In the Pieridiдæ, the movement, by which the median system seeks its extirpation, is arrested at this point; the cell never completely opening, although often degenerate, between M_2 and M_3, as in certain *Nymphalinæ*, in which, *per contra*, the upper two branchlets of the media never leave the cross-vein, crowding themselves into the upper corner, but refusing to ascend the radius. This is the general attitude of the brush-footed butterflies. The opening of the cell, wherever this happens by the disappearance of the cross-vein centrally, is the signal that the median system has finally departed; the radial and cubital systems of the wing inheriting its last possessions, the three terminal branchlets which they divide between them and subsequently have to feed. The base of the media had departed long ago; the veins running from the cross-vein to the root of the wing are now only found in the Tineides, although scars along the tegument of the cell and little backward jutting spurs on the cross-vein tell of their former existence in the Pierids as well. The movements of the veins belonging to the two systems are unequal.

The hind wings seem to show little movement of the veins; they have performed an antecedent work in the simplification of the radius, which shows as a single vein. The first radial branch has seemingly gone to make up the humeral cell, but in the Pierids, the humeral cell has itself become absorbed and all traces of the forking of the radius at base have vanished. I therefore notate the radius by a simple R; theoretically it should stand $R_2 + 3 + 4 + 5$, while the subcostal vein should stand Sc. $+ R_1$, marking where the radial branchlets have respectively disappeared to. The hind wings of the Nymphalids show a greater movement of the veins than those of the Pierids; in the brush-footed butterflies the disintegration of the median series seems here to find its impulse and the specialization of the hind wings is in a constant state of advance. This is seen by the opening of the cell on the secondaries of *Araschnia*, *Melitæa*, etc., while the cell on primaries remains still more or less perfectly closed. Evolution is more active with the fore wings of the Pierids, with the hind wings of the Nymphalids; in which latter the bunching of the median nervules at the upper corner of the cell seems to meet the requirements of their mode of flight.

Value of Generic Characters.

This study of the wings of the Pierids will, I think, demonstrate that there exists no standard by which we can decide what constitutes or how much character should underlie the idea of a genus. The difference between the genus and species idea is quantitative merely. The conception of a genus as an independent entity, as in itself a thing closed and with real outlines and bounds, which it only requires a trained understanding to recognize, is seen to be illusory. The apparent limits of the genera are due, like those of the species, to gaps in the record. When these gaps are slight the lumpers ignore them, forgetting that the main business of entomology is to exhibit differences, not to lay stress on resemblances. The needless erection of genera should, indeed, be avoided, no less than the overlooking of distinctive characters. But what is here "needless?" One can only illustrate what one subjectively considers needless by examples. The generic term *Xanthidia* seems to me quite unnecessary. On the other hand, I would retain the Anthocharid genera, although superficially much alike, because they emphasize certain stages in the specialization of the radius, which we are obliged to notice and discuss. *Tetracharis*, for instance, represents a four-branched type in which R_2 has not yet attained the *Trifurcula* position; as such it is as much entitled to a generic name as another form not yet recognized as a member of a chain in which the links are so continuous. Everywhere, however, the links exist or have existed. It is not only that it is improbable that Nature has here progressed by jumps, but we cannot draw the line anywhere with exactness between such jumps as shall, and such as shall *not* be entitled to generic recognition. It becomes thus a subjective question, to be settled by each observer, accordingly as he is soberly or extravagantly inclined in either direction, as to making many or making few genera. I myself tend in the direction of making many, for fear of passing over characters of structure and to avoid packing away distinct types of succession in one category. It becomes, finally, clearer, that many more kinds of butterflies have perished than are now to be seen; the tertiary and quaternary faunæ seem specifically different.

Certain of the characters of neuration here recognized as of generic value, so far as regards the movable veins or branchlets, are apt to appear as characters of variation within the limits of the same species of butterfly, although I have not noticed any variation of

the kind in the Pierids. In the Parnassiidæ I have recorded an individual variation in the position of *R2* and *M1* on the fore wings of *Zerynthia*. The fact that these variations take the normal direction, seems to denote, that they are shown by anticipation (specialization) by a part of the mass of individuals before becoming fixed for the species as a whole. I have found no sexual characters in the neuration; these appear to be limited to the outline of the wings. In the male, *e. g.*, *Tachyris*, the primaries are in special cases narrowed and more pointed at the tips; in *Dismorphia* there is added to this narrowness in the primaries a compensatory greater breadth in the secondary wings. The female wing has been preferred for study, since this sex seems the more conservative. I have, however, found no positive proof of this in the neuration, so far as the limited number of specimens studied will allow me to see. The neuration affords no assistance to the theory that the color and pattern of the female is influenced by atavism. In fact, I have not succeeded in showing that the color and veining move together at all closely, and have accordingly omitted almost everything not related to structure and shape of the wings. As with the Papilionides, however, a white color, while persistent throughout a line, seems to be at least a secondary, not a primary color. The male, *e. g.*, *Perrhybris*, *Prioneris*, *Phrissura*, *Huphina*, is apt to whiten, to become paler.

But in *Enantia melite* and in *Colias rhamni* the male is of a much deeper color, more yellow than the female, while the most specialized and the most generalized forms alike show pale colors in the Pieriddidæ. In size the butterflies seem to tend to becoming smaller, as seen in such specialized forms as *Phulia* and *Nathalis*.

The total impression we derive of the neuration is one of continuity. The forms lead from one to another with unequal gaps between the genera, hence the generic characters are unequal also. The changes in the position of the veins are no doubt mechanically caused by the strain of the organism against its media. The disparities are accentuated for the moment, related to those interferences in the world process which are the ultimate cause of all diversity in nature.

Genealogical Trees and Tables.

In proportion as an intelligible system underlies the drawing up of genealogical trees and tables of genera are they of use and

value. As I once said of the subgenera of *Apatela*, they serve to light up the subject from within. There exist genealogical twigs scattered up and down in literature which seem to me to have been drawn at haphazard, so little or no explanation is vouchsafed, and, on examination, so little system is displayed. But from Mr. Scudder's dangerous-looking cluster of spikes to the peaceful gulf stream of names which flows over Mr. Reuter's double page, the lines can be followed with the help of a pin, and one feels that the opportunity is offered for pleasantly acquiring exclusive information. It is, however, when I survey Sir George Hampson's phylogeny of the Syntomidæ, that the magnitude of the task before me, in preparing a similar table of the Pierid genera, becomes appalling. There are so many, many, a perfect trellis work of names, all bound together by short and sharp lines of descent and affinity. There are no doubts, no uncertainties; each title finds its exact place, as in a Chinese puzzle, which, if it were to fall apart, who could put together again? And when I look up the couple of names I have contributed to this ordered espalier, I am obliged to confess that never, never would I have been able to get them into their present situation. And there is no key to the puzzle, no showing how it is done. Why are *Metarctia*, *Pseudapiconoma*, *Zethes*, so placed? Why is *Hyaleucerea* at the bottom and *Urolasia* at the top? Why all the names between them? Why? Why? "*Pourquoy*, my dear knight?" As in the play, the question may be impatiently answered by another—"Do, or not do?" The idea of a genealogical tree being given, the lines must be drawn in every case, to give an idea of completeness, of mastery of the subject, and this seems rather to be Mr. Meyrick's conception and definition of Darwinism.

And yet these relationships, to be symbolized by these equal lines, are always unequally expressed and often in nature very obscurely indicated. The leading structural peculiarity of a large group once seized, it is not difficult to detect this distinguishing feature when it occurs in a second, otherwise differing group, to infer thereupon the phyletic connection, assign the respective grade of specialization and conclude by uniting the collective names by a line in a diagram. With genera, when numerous, the question becomes one of greater detail, the interrelations grow complicated; so that, if one insists upon drawing up a complete table and connecting all the names, the temptation in certain places to cut a Gordian knot by tying one becomes correspondingly frequent.

Despite, then, the preconception of authors, that their papers on their subject are final, yet it is seen that they are not so, and this from the complexity of the matter and the inability of the writer to look all around it. It was Dr. Johnson who said that the first care of the builder of a new system is to demolish the fabrics which are standing. I am afraid this may be repeated of some of our work on the Lepidoptera, and that this demolition is not always necessary. I should be sorry, however, to apply here the Doctor's further opinion that thus the human mind is kept in motion without progress. At the end of the last century there seems to me to be a clear residue of advance. The truth of evolution conceded, the great fact that the biological is part of the geological process admitted, it might seem superfluous to attempt to gauge the flight of butterflies, were they not fellow-passengers across the scene, and could we not detect in their fate the shadow of our own. No witness can be thought unnecessary whose testimony, even if silent, bears on the problem of life. Undoubtedly in this way our interest in the contents of Natural History Museums increases the more we consider them in relation to ourselves. Indeed, this is the deeper reason for the existence of all collections.

To return to our tables of genera: it is but too certain I can offer no such complete scheme of the Pierids as Sir George Hampson has given us of the Syntomids. Setting aside the incompleteness of my material, I do not know if *Pontia*, for instance, is surely an Anthocharid, or belongs to the typical line of *Pieris*. I do not even know if there is anybody who could tell me, so contradictory appears the evidence, and there are a number of questions, perhaps less crucial and more easily satisfactorily solved, as to which I am in doubt, and to resolve my doubts by drawing firm lines on a plan I am incapable. By a hundred points do these frail insects impinge on their surroundings and fade away into space. All that I can try to do is to see that the names along a horizontal line represent forms conforming, barring immeasurable inequalities, to a certain approximate grade of specialization, while those, in the same vertical line, succeed one another in the expression of one of the movements which I have elsewhere shown to occur in the position and number of the veins of the wing. Thus the succession represents ideally the probable or possible sequence in time and space. I use generic names only in connection with the structure of the type.

The Diphyletism of the Diurnals.

From unpublished photographs sent me by Prof. Comstock it appears that on primaries a bifurcate third anal vein is present in the pupa of *Pieris*, of which no trace is seen in the imago, unless we consider the thin piece, anastomosing with second anal at base, as a relic. If the homology of the free third anal vein of the imago of the Papilionides, with this thin piece (sometimes a mere scar, again wanting) joined outwardly to second anal of the imago of the Hesperiades, be denied, the definition given by me (Proc. Amer. Phil. Soc., xxxviii, 43) may be accepted. If, on the contrary, the homology be asserted, then the wording may be altered as follows:

A. Butterflies having a short third anal vein on primaries, running downwardly free from base of wing to internal margin; on secondaries only one anal vein. . . . . Papilionides.

B. Butterflies having a short third anal vein on primaries, joining outwardly the second anal vein (this fork sometimes wanting by reduction and always thinner than second anal or degenerate) and having more than one anal vein on secondaries . . . . . Hesperiades.

The question of the homology of the veins cannot affect (as I have elsewhere stated) the argument as to the diphyletism of the diurnals. A natural group in which a certain vein is free in the imago cannot well have the same origin with an opposed and equally natural group in which this same vein runs in an opposite direction and fuses with the next vein lying above it. The troublesome factor in the classification of the diurnals has been the position of the Papilionides. They have been approached violently to the Pierids and learned treatises have allied them with the Hesperids. And then they have been forcibly thrust in between the Blues and the Skippers, an inoculation which the genealogical tree most naturally resists. If we succeed in removing them from their enforced union with the Hesperiades, unexpected light may fall upon the history of the development of the Lepidopterous organization. Nor can we fit the Papilionides in between the Hesperiades and the moths, so that, in a linear arrangement, the only course remaining open for us to pursue is to head with them the series of the diurnals. The whole question of phylogeny is a relative one. Even if we can make out resemblances in

the embryonal wing, these do not abrogate the differences in the imaginal. These exist in the present instance, throwing the common origin of the two groups further back, and render the supposition tenable, that the Papilionides and Hesperiades, as butterflies, have a different origin. The conclusion to which I have come is this, that all the groups of the Hesperiades converge in ancestral types of the Skippers, to the entire exclusion of the Papilionides.

Objections will be made that the Skippers are so different from other butterflies. I have tried to show that these differences arise from secondary specializations and are not constant or peculiar. From a bend in the antennæ, classificators give such names as "Grypocera." But how about those Skippers which lack the bend? Are these, too, "Grypocera"? Again, some writers dwell with astonishment upon the fact that certain Skippers like to stroll in the dusk of evening, and these writers hold that, with such habits, these Skippers cannot be considered as orthodox diurnals. And then a special name is coined for them as a sort of atonement for heresy. But clearly all this arises from preconceived opinions, from want of consideration and weighing of characters. No value is given by these classificators to the exceptions which deprive their categories of proper support. All the characters shown by the Skippers are explainable by the fact that we have to do with a group originally transitional in habit and structure, and having become a fixed and natural one through custom.

The Evidence from Fossil Butterflies.

The evidence from paleontology is so scant that of itself it can have no deciding weight. One feature, however, which assists my ideas is that the tertiary deposits have yielded a larger proportion of Nymphalids. We might naturally expect, among the Hesperiades, that the groups in which the radius is specialized, viz., the Pierids and the Blues, would be more recent, succeeding in point of time the Skippers and the Nymphalids. I think we may assume the fact. In a recent valuable paper by Dr. Rebel, a restoration is given of the wing of *Lycænites*. This is a presumed lycænid, and there is no improbability in the view that the Blues may have been represented in the Miocene. But I wish to point out that a slight change in the restored wing parts would give us the Skipper type, in this case apparently one resembling the North American Megathymidæ, a group with generalized larvæ, and which may also have enjoyed a greater range and rep-

resentation in tertiary than in recent time. For the Miocene strata of central Europe contain a number of types of vertebrates and land shells which are now confined to America, but at that epoch enjoyed so wide a distribution. In Europe these types subsequently disappeared, giving place to more specialized types, but in America they have persisted. Without having seen the specimen I could not venture upon an opinion not in accord with that of so reliable an observer, and what I now point out is that the wings of the Blues and Skippers nearly agree, and I repeat that it is probable that the former group has emerged from the same immediate stock with the latter. Another circumstance to be noted is that the tertiary species are generally distinct. This leaves room for the supposition that the diurnals have changed both a good deal and comparatively rapidly. It seems that the Nymphalids flourished in the tertiary and that the quaternary is evidently the epoch of the Pierids and the Blues, so that we may safely regard these latter groups as among the more modern types of butterflies.

With regard to the phylogenetic line *A*, the Papilionides, we know, from Dr. Rebel's researches, that its most advanced group, the Parnassians, existed in the Miocene. No certain identification of fossil remains of the Swallowtails proper, the Papilionidæ, appears to have been yet made anywhere. But if my views are correct, we may yet discover that Ornithoptera-like forms had a wider distribution in preceding epochs than at the present time. The classification and the general theory of the development of the diurnals, brought forward in this present and previous communications to the American Philosophical Society, is so different from the general opinions and conclusions of other authors, that I have given them with diffidence and in all deference. My views have gradually shaped themselves out of the discovery of the directions of the movements which undoubtedly occur in the evolution of the veining of the Lepidopterous wing. While I have tried to correlate the subordinate types, I have endeavored to make it quite clear that there are two antagonistic and principal types in the neuration of the diurnals, and that this fact authorizes the belief that the Papilionides and Hesperiades may have had an independent origin.

Mimicry.

None of my predecessors appear to have studied the phenomena of mimicry in connection with the structure and specialization of

TABLE OF GENERA OF PIE

(Pierini)

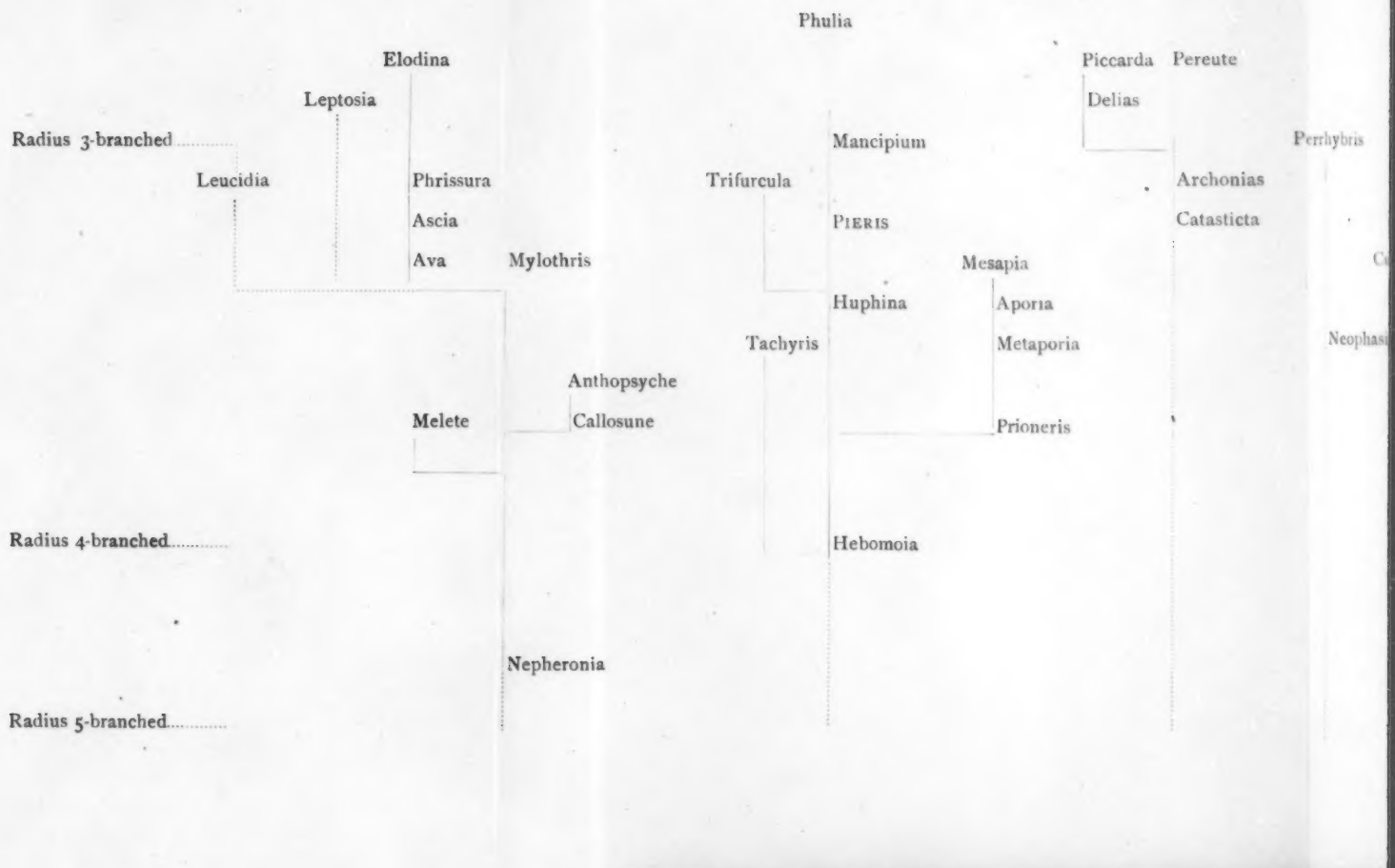
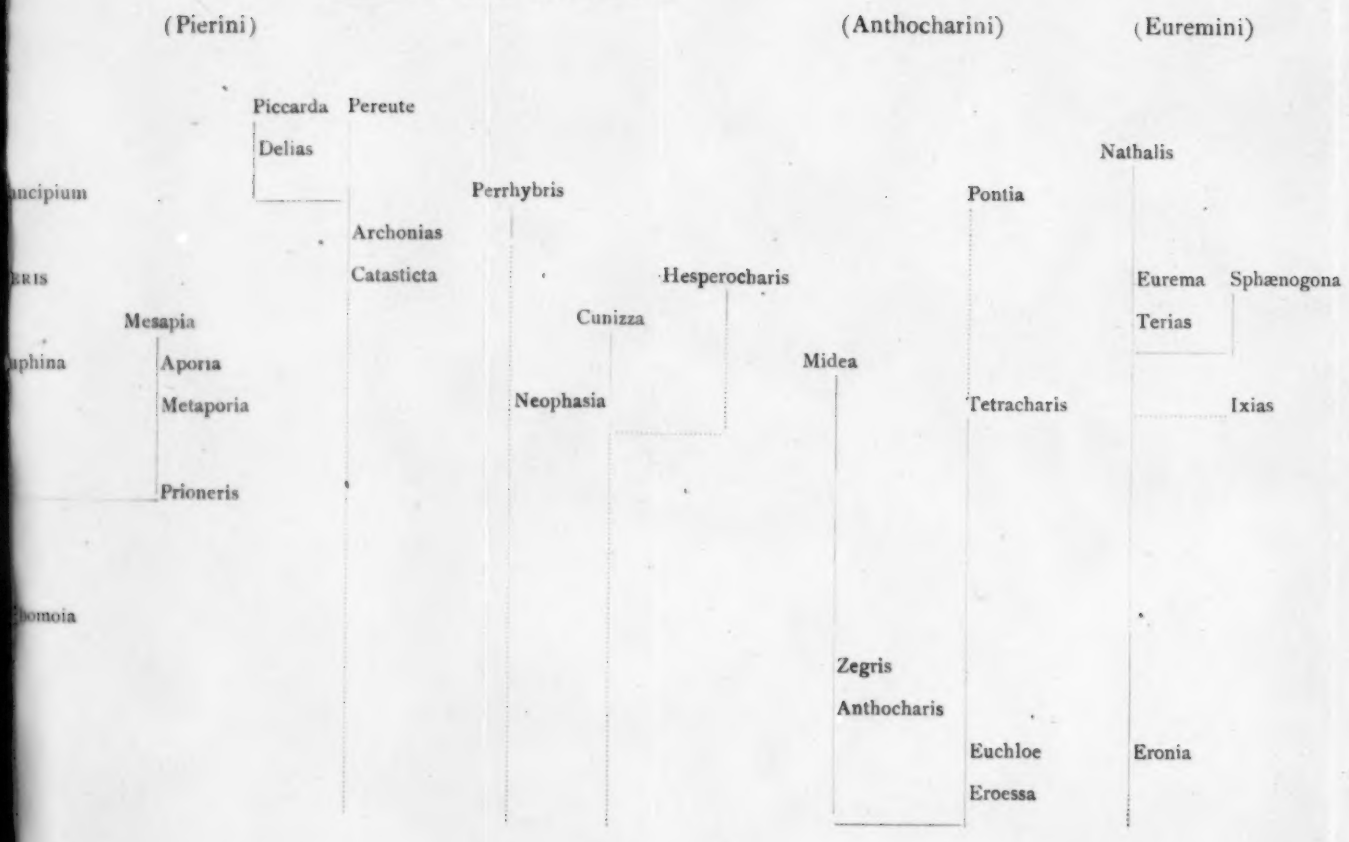
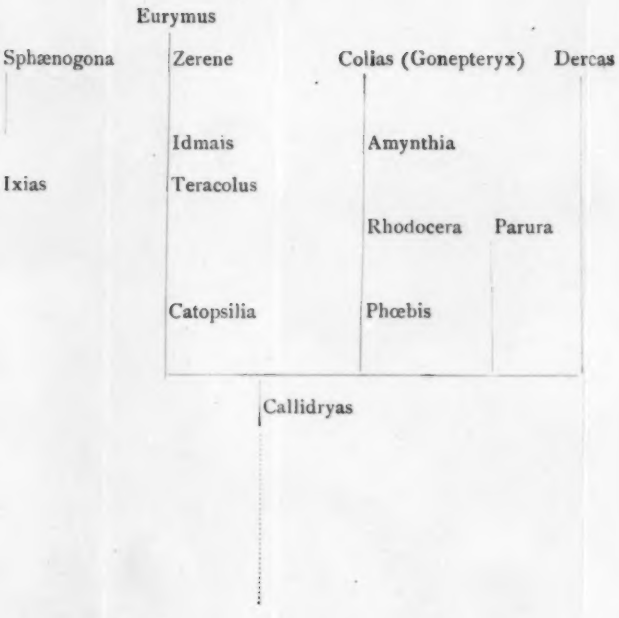


Table of Genera of Pieridiдæ.



ni)

(Eurymini)


Eurymus
Sphænogona
Zerene
Colias (Gonepteryx)
Dercas
Idmais
Amynthia
Ixias
Teracolus
Rhodocera
Parura
Catopsilia
Phœbis
Callidryas

the wings. It has been with them a question chiefly of color and pattern or outline. The conclusion to which these studies of the neuration lead is this: *The older and more generalized forms*, here Nymphalids and Papilionids, *serve as models; the younger and more specialized forms*, here Pierids and Dismorphians, *do the copying*. As yet I know of no older type which has assumed the dress of a younger. Mimicry would thus fall in with other phenomena of succession, and is deprived of the appearance of fortuity which now clings to it in literature.

System of Notation.

In the designation of the veins I have followed here the same system as in my other papers, with the exception that I have adopted Prof. Comstock's recent change with regard to the longitudinal veins. These are indicated by an initial letter of the name instead of a Roman numeral. On the fore wings the subcostal is marked *S*; the radius by *R*, with the Arabic numerals 1 to 5 for the branches; the Media by *M*1 to 3; the Cubitus by *C*1 to 2; the anal veins by *A*1 to 3; the third anal is wanting in the Hesperiades, unless the more or less illegible straight prong from the second anal at base be homologous with it. The costal vein is absent by reduction on both wings; on the primaries the thickening of the costal edge may or may not be a trace of it, and in any event is of no importance to designate. On the hind wings I have suggested (January, '99) that the so-called "precostal spur" is homologous with the "humeral veins" of Prof. Comstock, multiplied in the Lachneids. In a letter to me Prof. Comstock adopts this view and suggests the prong should be so notated. I prefer to call it the "humeral spur" and to mark it "h. s."; the word "vein" might cause a confusion with a longitudinal vein. The subcostal of the hind wings has absorbed apparently, Prof. Comstock tells me, the first branch of the radius as part of the humeral cell. Since this is obsolete in the present group, I have marked the vein here as on the primaries with a simple *S*. The radius of hind wings is reduced to a single vein, representing *R*2 + 3 + 4 + 5, the branch *R*1 having gone apparently with the subcostal; but, since this cannot be seen in the present group, there is no use in complicating the notation and I use merely the letter *R*. The other veins are as on fore wings. The persistent anal vein is the

second; the first is also the first to disappear, followed by the fourth and third.

The humeral spurs of the Lachneidæ have been cited as examples of specialization by addition in the wings of the Lepidoptera. This may have been their origin. They appear to attain their maximal development on the secondaries of *Eutricha quercifolia* (consult Grote, *Ill. Zeits. f. Entom.*, Band 4, Heft 4, Fig. 1). In the diurnals the spurs would be already reduced to a single one. But even in the Lachneids the generic types I have examined have them very unequally developed. And they may have appeared independently in different groups. The repetition of the neuration, as might be expected in homodynamic organs like the wings, is, so far as I know, always exact. Slight variational changes in the position of the veins, following the general directions of specialization, are repeated on both sides of the insect. Accidental aberrations, failures in development, are of unequal, local origin and have a special cause. The two classes of individual deviation from a given type should be discriminated.

The bending inwardly of *A* 3 on the secondaries of *Elodina egnatia* (Fig. 10) leaves a wide, unsupported lobe at the base of the wing, which seems to be traversed by an irregular, linear thickening of the membrane, having the false appearance of a vein. This would be secondary and its origin analogous with that of the humeral spurs. But the feature must be studied from more material than at the moment is at my disposal. It is possible that the last anal vein (*A* 4) in *Pseudopontia*, marked in my figure "ix," is homologous with this thickening in *Elodina;* in both *A* 3 is bent inwardly. Compare these PROCEEDINGS, xxxvii, No. 157, Pl. i, Fig. 7.

ACKNOWLEDGMENTS.

After wandering for nearly forty years in the wilderness of butterflies, it may be the last time I have the opportunity of expressing my indebtedness to other students and their works. And first I return thanks to Prof. Comstock for the assistance which his publications on the wings of the Lepidoptera have been to me, no less than for his kind communications upon debatable points. Prof. Comstock has worked out, with immense patience and labor, a system of notation applicable to the veins of all insect wings, and which is here adopted for the butterflies. Thus the original idea of Redtenbacher, who must not be forgotten, has, I hope, received its

practical realization. Nor should the work of Herrick-Schaeffer upon the veining, even if partial and exclusive, be passed over. This author was the true successor of Hübner, who troubled himself alone with color and pattern and shape, not going beneath the surface of the wings. If I mention again Mr. Scudder's *Historical Sketch*, it is to renew the expression of my hope that the book may be republished and brought down to date. No one can do this so well as the gifted and industrious author whose acquaintance I have enjoyed for all these years and for whom I feel undiminished esteem. If I have opposed his classification of the butterflies, I have used, in my efforts to subvert it, the same weapons employed by him to defend it. I am anxious to say a thankful word to Mr. W. H. Edwards for his letters and the information he has given me and all of us on the North American butterflies. With Dr. Packard, I am one of four authors who, commencing to write at about the same time on American Lepidoptera before the war, have lived until to-day to see much that they have accomplished adopted, and, in a varying degree, also disputed. It must be our reward to have worked for the spread of knowledge according to our differing lights—*manifesta rotæ vestigia cernes.*

I am glad again to thank Mr. W. F. Kirby, of the British Museum (Natural History), for his complaisance in affording me information not to be found in Mr. Scudder's book. Mr. Quail's papers on the neuration have been suggestive to me. I am indebted to Dr. Chapman for letters and copies of his ingenious papers on the pupæ of butterflies. Finally I am indebted to Dr. O. Staudinger and A. Bang Haas for determinations which give this work an element of certainty as to the identity of material which it could not have had from my own authority.

Explanation of Plate I.

The figures are obtained by an improved photo-lithographic process. S = subcostal vein; R = radius 1 to 5; M = media 1 to 3; C = cubitus 1 to 2; A = anal 1 to 3. The costal veins are absent in the Lepidoptera through reduction. The fork at base of second anal of primaries is not numbered. The first anal is usually obsolete. On hind wings h. s. = humeral spur.

Fig. 1. *Azalais gigantea.* Type of genus. This immaculate and more specialized form differs from *Leptidia* by the production of the primary wing between *M*1 and 2. On hind wings the position of *M*1 is further removed outwardly and *M*2 is nearer 3; the humeral spur is also straight and truncate.

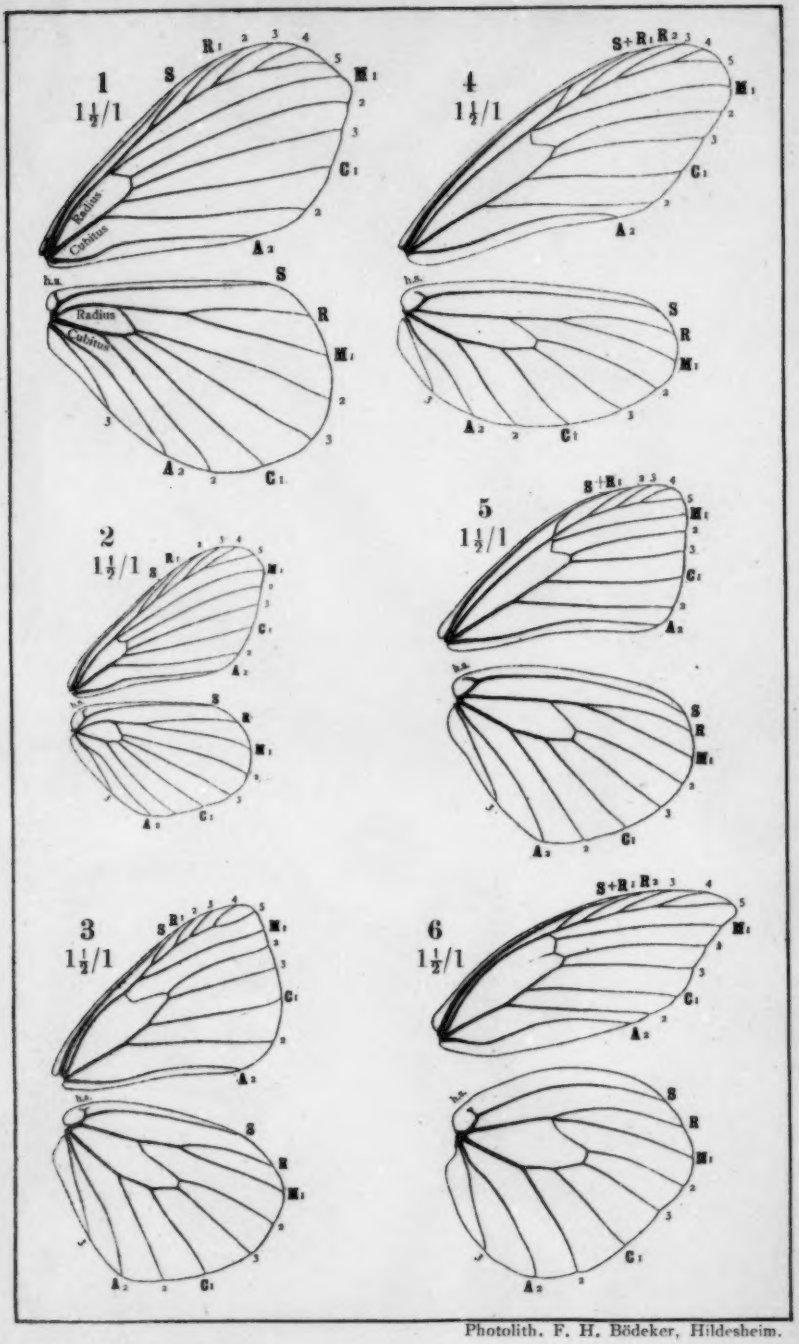
Fig. 2. *Leptidia sinapis.* Type of genus and subfamily. This latter is characterized, as compared with the Dismorphianæ, by the retreating discal cells and central position of second median on primaries. No trace of fork to second anal. Compare with preceding figure.

Fig. 3. *Pseudopieris nehemia* ♀. Type of genus. An isolated and specialized form belonging to the Dismorphianæ, which have proportionate discal cells and second median vein cubital on both wings. In *Pseudopieris* the cell retreats in its upper part, leaving the first median on primaries free from radius. The first radial is free to costa; h. s. Y-shaped. The uniformly pale color here accompanies a peculiar specialization in the veining.

Fig. 4. *Leptalis astynome* ♀. Type of genus. The first radial fuses with subcostal; first median from radius at upper corner of discal cell. On hind wings *M*1 from radius well beyond discal cell.

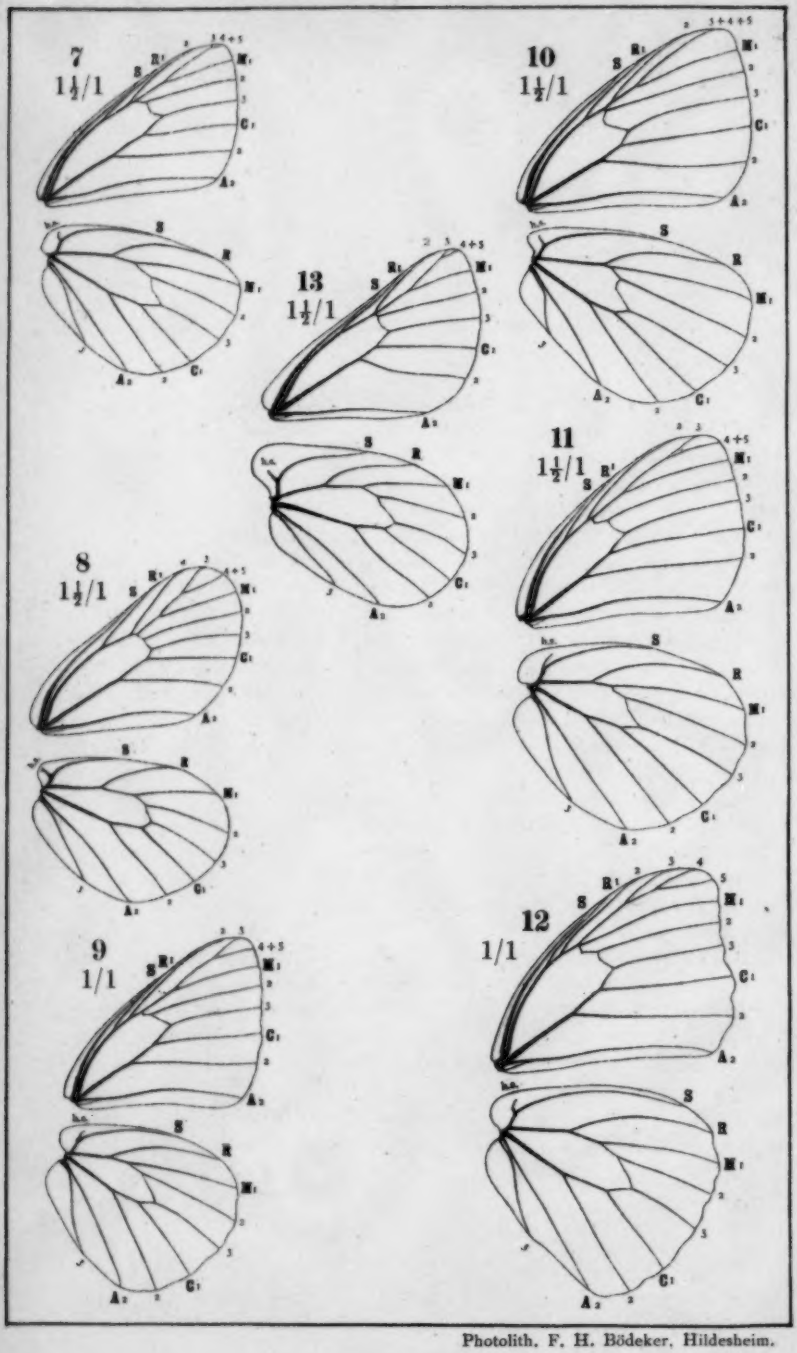
Fig. 5. *Enantia melite* ♀. Type of genus. The first radial branch is bent and fused with subcostal. *M*1 from cross-vein close to upper corner of discal cell, hence more generalized than *Leptalis.*

Fig. 6. *Acmepteron nemesis* ♂. Type of genus. The proportions of the wings are Orthopteralike. The backward spur on discal cell, a relic of the base of media, marks the generalization. *R*1 straight, fusing with subcostal. *M*1 from cross-vein, further removed from upper corner of cell than in *Enantia*, hence the more generalized form. Hind wings with discal cross-vein joining *M*1 at furcation with radius. This dark form has ancestral characters compared with the two preceding. The Leptidianæ belong to the fauna of the Old, the Dismorphianæ to that of the New World.



Photolith. F. H. Bödeker, Hildesheim.

A. Radcliffe Grote — Wings of Butterflies.



Photolith. F. H. Bödeker, Hildesheim.

A. Radcliffe Grote — Wings of Butterflies.

Explanation of Plate II.

The figures are obtained by an improved photo-lithographic process. S = subcostal; R = radius 1 to 5; M = media 1 to 3; C = cubitus 1 to 2; A = anal 1 to 3. The first anal vein is obsolete; the thin fork to second anal is not numbered. On hind wings h. s. = humeral spur.

Fig. 7. *Pieris napi.* Note the Pierine and original position of $R1$ and 2 above the cell; though here $R2$ is advanced nearly to cross-vein, and in this is *P. napi* a slightly more specialized form than the type of the genus *P. rapæ*, as also in that the fork $R3$ is still more reduced. On hind wings h. s. abbreviate, curving outwardly. The fork to second anal on fore wings is thin, but apparently a functional vein. Compare Schm. Hild. Taf. I, Fig. 5, for figure of *P. rapæ*.

Fig. 8. *Mesapia peloria.* Type of genus, belonging to the opaque-veined *Aporia* series. When compared with *Pieris*, more generalized, the fork of $R3$ being longer. Consult the figure of *Aporia*, cited in text, for comparative details.

Fig. 9. *Mylothris rhodope.* Type of genus; a four-branched form belonging to the *Ascia* series; $R1$ and $R2$ in the original Pierine position above the cell; the veinlet $R3$ is slightly bent just below costa (as in *Mancipium*), showing that an additional radial veinlet has shortly been given up.

Fig. 10. *Elodina egnatia* ♀. Type of genus; belongs to the clear-veined, thin and wide-winged *Ascia* group, convergent with *Pieris*. The most specialized form, as shown by the radius, being three-branched, and $R2$ advanced beyond cross-vein. Compare text.

Fig. 11. *Phrissura ægis* ♀. Type of genus; a more generalized form than *Elodina*, as shown by the four-branched radius; $R2$ not advanced as far as the cross-vein, still in the Pierine position. Compare, for these points, with preceding figure.

Fig. 12. *Nepheronia poppea* (*idotea*). Type of genus. This is the generalized form of *Mylothris* (Fig. 9), and in which the radius is five-branched. $R2$ is further from cross-vein than in the more specialized *Mylothris*, of which this is probably the direct ancestral form. The shape of primaries is different from *Mylothris*, the pattern identical. The fork to second anal is here very thin and perhaps hardly functional.

Fig. 13. *Trifurcula huanco* ♂. The primary wing shows the *Trifurcula* position of $R2$, advanced to just opposite the cross-vein. Compare text.

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Explanation of Plate III.

The figures are obtained by an improved photographic process. S = subcostal vein; R = radius 1 to 5; M = media 1 to 3; C = cubitus 1 to 2; A = anal 1 to 3. On hind wings h. s. = humeral spur. The thin fork at base of second anal of primaries is not numbered. The costal vein is absent through reduction on both wings in the Lepidoptera.

Fig. 14. *Piccarda eucharis* ♀. Type of genus. A highly specialized Pierid, in which the radius of forewings is three-branched; $R2$ has left the original Pierine position above the cell and traveled along radius until it forms but a moderate fork with $R3+4+5$, before apex. $M1$ has ascended the radius on its lower edge for a considerable distance beyond the cross-vein; hence this is the specialized form of the succeeding *Delias*. In both genera the fork to second anal of primaries is reduced to a mere scar.

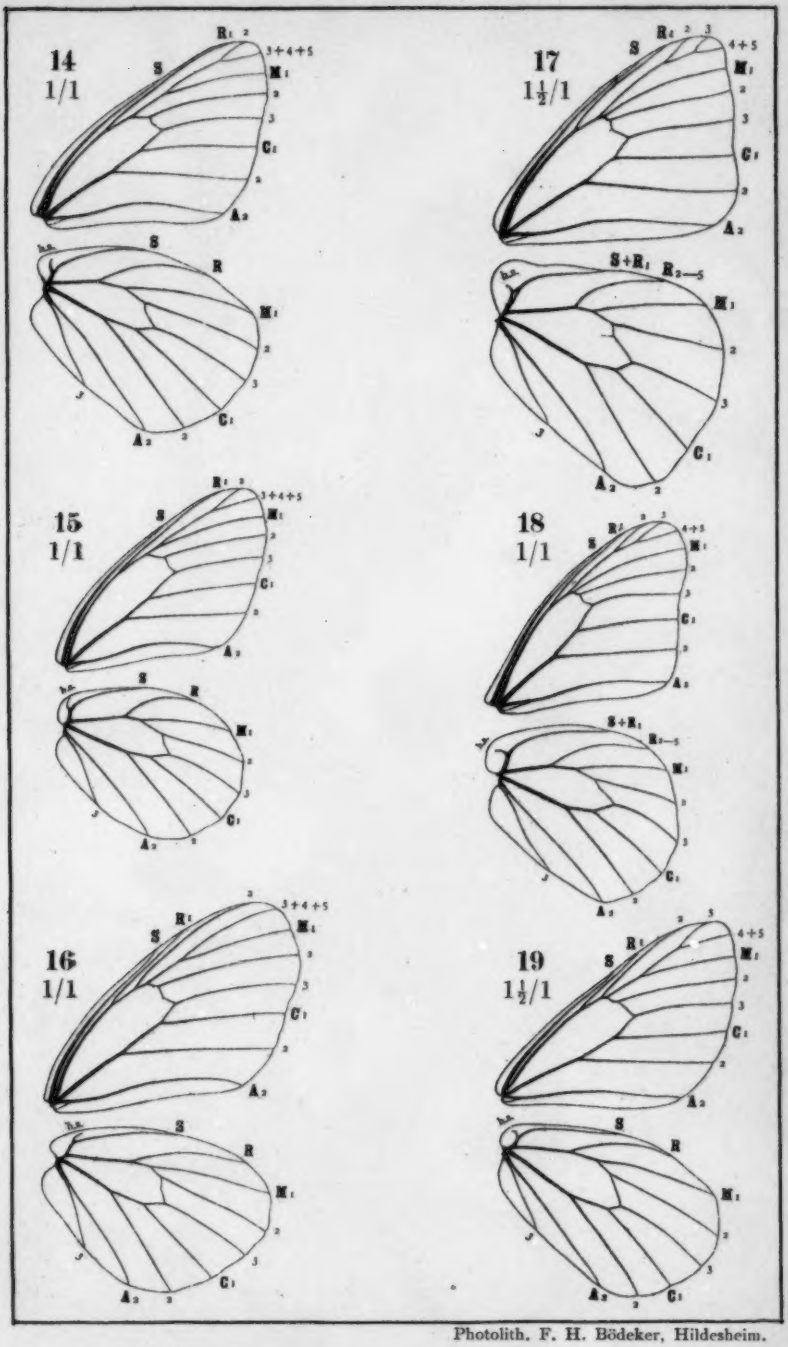
Fig. 15. *Delias egialea* ♀. Type of genus. Compare with *Piccarda* as to position of $M1$, which here leaves radius immediately beyond junction of cross-vein; fork of $R2$ longer than in *Piccarda*. In these genera the specialization of radius has outstripped that of media, and reaches its fullest expression yet attained.

Fig. 16. *Pyrrhybris pyrrha* ♀. Type of genus. A specialized Pierid in which $R2$ has retained the Pierine position above discal cell and has not traveled along radius. Hence this is more generalized than the preceding, although the radius is equally three-branched. Compare text.

Fig. 17. *Hesperocharis erota*. Type of genus. Radius four-branched, the branches $R2$, $R3$, short, near together before apices, taking Anthocharid position; h. s. truncate.

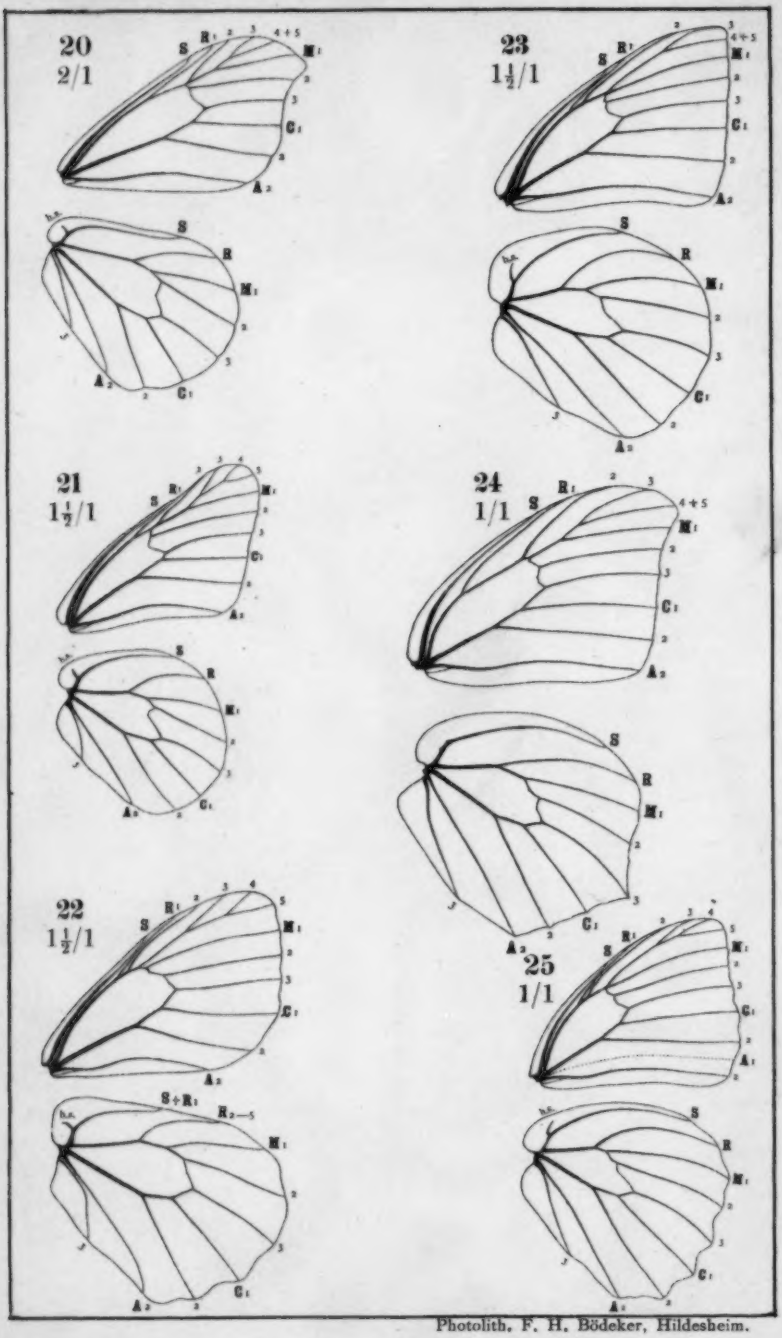
Fig. 18. *Cunizza hirlanda*. Type of genus. Primaries with blunt and rounded apices, contrasting in shape with *Hesperocharis*. $R2$ to 3 longer, and $M1$ a little further from radius on crossvein, hence more generalized than *Hesperocharis*.

Fig. 19. *Neophasia menapia*. Type of genus. A typical Pierid in which $R2$ keeps its original position above cell, but here well advanced. Radius four-branched. Probably a form ancestral to *Pyrrhybris*, or slightly divergent on the same line of specialization.



Photolith. F. H. Bödeker, Hildesheim.

A. Radcliffe Grote — Wings of Butterflies.



Photolith. F. H. Bödeker, Hildesheim.

A. Radcliffe Grote — Wings of Butterflies.

Explanation of Plate IV.

The figures are obtained by an improved photographic process. S = subcostal vein; the costal vein is absent through reduction in the Lepidoptera; R = radius 1 to 5; M = media 1 to 3; C = cubitus 1 to 2; A = anal 1 to 3. On secondaries h. s. = humeral spur. The thin fork to second anal of primaries at base is not numbered.

Fig. 20. *Midea genutia.* Type of genus. A four-branched Anthocharid, in which $R2$ has just passed out of the *Trifurcula* position opposite cross-vein. Compare with *Tetracharis*, in which $R2$ has not reached the cross-vein.

Fig. 21. *Zegris eupheme.* Type of genus. A five-branched Anthocharid, in which $R2$ has just passed the *Trifurcula* position. A more generalized form than *Midea*.

Fig. 22. *Eroessa chilensis.* Type of genus. One of the most generalized Pierids, ancestral to the Anthocharid line. Radius five-branched; $R2$ in original position above the cell and close to $R1$, which latter branchlet alone always remains constant in position and does not shift. The first median branchlet, which in all other Anthocharid genera has ascended radius and springs from it outside of cell, here retains its primitive position on cross-vein. This rare type is most instructive in supplying a generalized stage, rendering the succeeding steps of specialization in the position of the veins understandable. Compare these three figures with those of Anthocharid genera on Plate I, Vol. xxxvii, of these Proceedings.

Fig. 23. *Teracolus subfasciatus.* Type of genus. An African form more generalized than *Eurymus* (see Proceedings of the American Philosophical Society, Vol. xxxvii, Pl. II, Fig. 8), with which it must be compared. It seems ancestral to *Eurymus*, in that $R2$ has retained original position.

Fig. 24. *Amynthia mærula.* Type of genus. This figure will serve to illustrate the wings of that line of the Eurymini in which the primaries have assumed a leaflike shape. Compare Schm. Hild. Taf. II, Fig. 8, for wings of its ally, *Colias rhamni*.

Fig. 25. *Eronia cleodora.* Type of genus. A generalized, radially five-branched form of the Euremini, which should be compared with *Eroessa* and *Nepheronia*. The resemblances suggest that these generalized types approach in wing structure. The five-branched types are rare in the Pierids, but in the brush-footed butterflies this generalized type of the radius is normal and never abandoned. In the primitive Pierid wing the radius was five-branched, and upon this character all the Hesperiades meet. The greatest divergence from this type is to be found in specialized Pierids, such as *Pontia* and *Piccarda*.

Stated Meeting, January 19, 1900.

Vice-President WISTAR in the Chair.

Present, 32 members.

Messrs. William Brooke Rawle, Robert C. H. Brock and Barton C. Hirst, newly elected members, were presented to the Chair, and took their seats in the Society.

Letters accepting election to membership were received from Profs. James Dewar, Barton C. Hirst, William H. Holmes, Jacques Loeb, A. B. Meyer, Sir William Henry Preece and Prof. Charles Otis Whitman.

Donations to the Library were announced.

The Curators announced the donation of a portrait of our late fellow-member, Dr. D. G. Brinton, from his friends, and of a medal from the Numismatic and Antiquarian Society, for which the thanks of the Society were ordered.

Dr. I. Minis Hays then read a paper entitled "A Contribution to the Bibliography of the Declaration of Independence."

R. H. Mathews, of Paramatta, N. S. Wales, presented a paper on "Divisions of the South Australian Aborigines."

Mr. Robert Paterson Field made some remarks on Col. William Anderson and presented a photograph of a portrait of Gen. Washington by Charles Wilson Peale, and exhibited the portrait.

Dr. I. Minis Hays was unanimously reëlected Librarian for the ensuing year.

The meeting was adjourned by the presiding officer to Friday, February 2, at five minutes before 8 P.M.

Adjourned Stated Meeting, January 19, 1900, February 2, 1900.

Vice-President BARKER in the Chair.

Present, 14 members.

A communication was read from President Fraley, making the following nominations for the Standing Committees for 1900:

Finance.—Philip C. Garrett, William V. McKean, Joel Cook.

Hall.—Horace Jayne, Joseph M. Wilson, Harold Goodwin.

Publication.—Henry Carey Baird, Patterson DuBois, I. Minis Hays, Joseph Willcox, Morris Jastrow, Jr.

Michaux Legacy.—Thomas Meehan, Angelo Heilprin, William P. Wilson, Burnet Landreth, Joseph T. Rothrock.

Library.—George F. Barker, T. Hewson Bache, Albert H. Smyth, Joseph G. Rosengarten, Edwin G. Conklin.

On motion, these nominations were received and the Society chose those named for membership in the Committees as stated.

The meeting was then adjourned by the presiding officer.

A CONTRIBUTION TO THE BIBLIOGRAPHY OF THE DECLARATION OF INDEPENDENCE.

(Plate V.)

BY I. MINIS HAYS, M.D.

(*Read January 19, 1900.*)

When the Declaration of Independence was agreed to by the Congress on the afternoon of Thursday, July 4, 1776, it was thereupon

"*Ordered*, That the Declaration be authenticated and printed.

"That the Committee appointed to prepare the Declaration superintend and correct the press.

"*Resolved*, That copies of the Declaration be sent to the several

Assemblies, Conventions and Committees, or Councils of Safety, and to the several Commanding Officers of the Continental Troops; and that it be proclaimed in each of the *United States*, and at the head of the Army" (*American Archives*, 4th Series, Vol. vi, p. 1731; also *Journal of Congress*, 1776, p. 247).

The Declaration, in accordance with the above order, was then authenticated by writing under it "Signed by Order and in Behalf of the Congress, John Hancock, President. Attest, Charles Thomson, Secretary." And the original manuscript was, in all likelihood as I have elsewhere indicated,[1] immediately sent to the printer, since the exigencies of the occasion did not allow of the delay necessary to copy it, either into the rough Journal of the Congress, or for the use of the printer. It was, probably, that same evening put in type and the proof corrected by the Committee which drafted it, and was printed off, as a broadside, early the next morning in time to furnish copies upon the reassembling of the Congress. A printed copy was then wafered in the blank space left for it in the rough Journal of the Congress, before the reading, on the morning of the 5th, of the Minutes of the preceding day.

This broadside constitutes the first edition of the Declaration. It was printed at Philadelphia by John Dunlap, the official printer to the Congress, and the copy wafered in the rough Journal of the Congress is facsimiled in Buchanan's *Genealogy of the McKean Family of Pennsylvania* (Lancaster, 1890), page 38. Copies of this edition are in the Emmet Collection in the New York Public Library (EM. 1528), in the Massachusetts Historical Society's collection and in the Library of Congress. It measures on the print 11¾ inches in breadth by 17 inches in length.[2] This edition corresponds with the first and so-called second editions (Nos. 101 and 102, which are in reality one and the same,) of Mr. Paul Ford's *Bibliography of the Official Publications of the Continental Congress*.

The line for line transcript of the head lines and colophon of this edition is as follows:

In Congress, July 4, 1776 | A Declaration | By the Representatives of the | United States of America, | In General Congress

[1] PROC. AMER. PHILOS. SOC., Vol. xxxvii, p. 102.

[2] I am indebted for these measurements to the courtesy of Mr. Wilberforce Eames, of the Lenox Library, New York.

Assembled | . . . . | Signed by Order and in Behalf of the Congress | John Hancock, President. | Attest. | Charles Thomson, Secretary | Philadelphia: Printed by John Dunlap.

Copies of this broadside edition of the Declaration were at once sent, by President Hancock, in accordance with the resolution of the Congress, "to the several Assemblies, Conventions and Committees, or Councils of Safety, and to the several Commanding Officers of the Continental Troops."

The minutes of the Council of Safety of the Province of Pennsylvania for Saturday, July 6, 1776,[1] state that

"The President of the Congress this day sent the following Resolve of Congress, which is directed to be entered on the Minutes of this Board:

"In Congress, 5th July, 1776.

"*Resolved*, That Copies of the Declaration be sent to the several Assemblies, Conventions, and Councils of Safety, and to the several Commanding Officers of the Continental Troops, that it be proclaimed in each of the United States and at the Head of the Army. "By order of Congress,

"Sign'd, John Hancock, Presid't.

"In consequence of the above Resolve, Letters were wrote to the Counties of Bucks, Chester, Northampton, Lancaster, and Berks, Inclosing Copy of the said Declaration, requesting the same to be publish'd on Monday next, at the places where the Election for Delegates are to be held."[2]

On the afternoon of the same day the Council of Safety

"*Ordered*, That the Sheriff of Philad'a read, or Cause to be read and proclaimed at the State House, in the City of Philadelphia, on Monday, the Eighth day of July, instant, at 12 o'Clock at Noon of the same day, the Declaration of the Representatives of the United Colonies of America, and that he cause all his Officers and the Constables of the said City, to attend the reading thereof.

"*Resolved*, That every Member of this Committee in or near the City, be ordered to meet at the Committee Chamber, before 12

[1] *Colonial Records*, Vol. x, p. 634.

[2] In *Penna. Magazine of History*, etc., 1892, Vol. xvi, p. 309, will be found a facsimile of the bill of Michael Kuhn to the Committee of Safety and approved by Owen Biddle, for £11 12, 6 for riding as an express to Chester, Lancaster, Potts-Grove and Bucks in accordance with the above resolve.

o'Clock, on Monday, to proceed to the State House, where the Declaration of Independence is to be proclaimed."

As is well known, the Declaration was read and proclaimed on the 8th by John Nixon, on behalf of William Dewees, the Sheriff of Philadelphia, from the platform of the observatory in the State House Square which had been erected by the American Philosophical Society to observe the transit of Venus in June, 1769.

The printed copy from which it was read, and, presumably, the copy enclosed to the Council of Safety by the President of the Congress, was carefully preserved by Mr. Nixon and is now in the possession of his descendant, Mrs. Charles C. Harrison, of Philadelphia.

A copy of the Declaration was likewise transmitted to General Washington, and we find that on July 9 he sent orders from New York to General Ward to "cause this Declaration to be immediately proclaimed at the head of the Continental Regiments in the Massachusetts Bay" (*Am. Archives*, 5th Series, Vol. i, p. 142) and on the eleventh he wrote to General Schuyler that in obedience to the order of Congress the enclosed Declaration "must be proclaimed throughout the Northern Army" (*ibid.*, p. 194).

Among the "Washington Papers" in the Department of State there is a broadside copy, which Mr. Andrew H. Allen, Chief of the Bureau of Rolls and Library, informs me, is believed to be the copy sent by the President of the Congress to General Washington to be read at the head of the Army.

The Washington and Nixon copies are of the same edition as that wafered in the rough journal of the Congress.

There has recently been found among the unarranged papers of this Society a large and handsome broadside of the Declaration printed on vellum by John Dunlap, whose printing office was in Philadelphia and who was the official printer to the Congress, and to the Council of Safety of the Province of Pennsylvania. This edition appears to be unknown to the bibliographers of the Declaration, and I have been unable to learn of a copy being in any of the principal collections in the country. I am informed by Mr. Andrew Allen that it is not to be found in the Bureau of Rolls and Library of the Department of State at Washington.

The following is a line for line transcript of the head lines of this which appears to be the second edition of the Declaration:

A DECLARATION

By the Representatives of the

UNITED STATES OF AMERICA,

In General Congress Assembled.

IN CONGRESS, JULY 4, 1776.

A DECLARATION

BY THE REPRESENTATIVES OF THE

UNITED STATES OF AMERICA,

IN GENERAL CONGRESS ASSEMBLED.

WHEN in the Course of human Events, it becomes necessary for one People, to dissolve the Political Bands which have connected them with another, and to assume among the Powers of the Earth, the separate and equal Station to which the Laws of Nature and of Nature's God entitle them, a decent Respect to the Opinions of Mankind requires that they should declare the Causes which impel them to the Separation

We hold these Truths to be self-evident, that all Men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty, and the Pursuit of Happiness.—That to secure these Rights, Governments are instituted among Men, deriving their just Powers from the Consent of the Governed, that whenever any Form of Government becomes destructive of these Ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its Foundation on such Principles, and organizing its Powers in such Form, as to them shall seem most likely to effect their Safety and Happiness. Prudence, indeed, will dictate that Governments long established should not be changed for light and transient Causes; and accordingly all Experience hath shewn, that Mankind are more disposed to suffer, while Evils are sufferable, than to right themselves by abolishing the Forms to which they are accustomed. But when a long Train of Abuses and Usurpations, pursuing invariably the same Object, evinces a Design to reduce them under absolute Despotism, it is their Right, it is their Duty, to throw off such Government, and to provide new Guards for their future Security. Such has been the patient Sufferance of these Colonies; and such is now the Necessity which constrains them to alter their former Systems of Government. The History of the present King of Great-Britain is a History of repeated Injuries and Usurpations, all having in direct Object the Establishment of an absolute Tyranny over these States. To prove this, let Facts be submitted to a candid World.

He has refused his Assent to Laws, the most wholesome and necessary for the public Good.

He has forbidden his Governors to pass Laws of immediate and pressing Importance, unless suspended in their Operation till his Assent should be obtained; and when so suspended, he has utterly neglected to attend to them.

He has refused to pass other Laws for the Accommodation of large Districts of People, unless those People would relinquish the Right of Representation in the Legislature, a Right inestimable to them, and formidable to Tyrants only.

He has called together Legislative Bodies at Places unusual, uncomfortable, and distant from the Depository of their public Records, for the sole Purpose of fatiguing them into compliance with his Measures.

He has dissolved Representative Houses repeatedly, for opposing with manly Firmness his Invasions on the Rights of the People.

He has refused for a long Time, after such Dissolutions, to cause others to be elected; whereby the Legislative Powers, incapable of Annihilation, have returned to the People at large for their Exercise; the State remaining in the mean Time exposed to all the Dangers of Invasion from without, and Convulsions within.

He has endeavoured to prevent the Population of these States; for that Purpose obstructing the Laws for Naturalization of Foreigners; refusing to pass others to encourage their Migrations hither, and raising the Conditions of new Appropriations of Lands.

He has obstructed the Administration of Justice, by refusing his Assent to Laws for establishing Judiciary Powers.

He has made Judges dependent on his Will alone, for the Tenure of their Offices, and the Amount and Payment of their Salaries.

He has erected a Multitude of new Offices, and sent hither Swarms of Officers to harrass our People, and eat out their Substance.

He has kept among us, in Times of Peace, Standing Armies, without the Consent of our Legislatures.

He has affected to render the Military independent of and superior to the Civil Power.

He has obſtructed the Adminiſtration of Juſtice, by refuſing his Aſſent to Laws for eſtabliſhing Judiciary Powers.
He has made Judges dependent on his Will alone, for the Tenure of their Offices, and the Amount and Payment of their Salaries.
He has erected a Multitude of new Offices, and ſent hither Swarms of Officers to harraſs our People, and eat out their Subſtance.
He has kept among us, in Times of Peace, Standing Armies, without the Conſent of our Legiſlatures.
He has affected to render the Military independent of and ſuperior to the Civil Power.
He has combined with others to ſubject us to a Juriſdiction foreign to our Conſtitution, and unacknowledged by our Laws; giving his Aſſent to their Acts of pretended Legiſlation.
For quartering large Bodies of Armed Troops among us:
For protecting them, by a mock Trial, from Puniſhment for any Murders which they ſhould commit on the Inhabitants of theſe States:
For cutting off our Trade with all Parts of the World:
For impoſing Taxes on us without our Conſent:
For depriving us, in many Caſes, of the Benefits of Trial by Jury:
For tranſporting us beyond Seas to be tried for pretended Offences:
For abolishing the free Syſtem of Engliſh Laws in a neighbouring Province, eſtabliſhing therein an arbitrary Government, and enlarging its Boundaries, ſo as to render it at once an Example and fit Inſtrument for introducing the ſame abſolute Rule into theſe Colonies:
For taking away our Charters, abolishing our moſt valuable Laws, and altering fundamentally the Forms of our Governments.
For ſuſpending our own Legiſlatures, and declaring themſelves inveſted with Power to legiſlate for us in all Caſes whatſoever.
He has abdicated Government here, by declaring us out of his Protection and waging War againſt us.
He has plundered our Seas, ravaged our Coaſts, burnt our Towns, and deſtroyed the Lives of our People.
He is, at this Time, tranſporting large Armies of foreign Mercenaries to compleat the Works of Death, Deſolation, and Tyranny, already begun with Circumſtances of Cruelty and Perfidy, ſcarcely paralleled in the moſt barbarous Ages, and totally unworthy the Head of a civilized Nation.
He has conſtrained our fellow Citizens taken Captive on the high Seas to bear Arms againſt their Country, to become the Executioners of their Friends and Brethren, or to fall themſelves by their Hands.
He has excited domeſtic Inſurrections amongſt us, and has endeavoured to bring on the Inhabitants of our Frontiers, the mercileſs Indian Savages, whoſe known Rule of Warfare, is an undiſtinguiſhed Deſtruction of all Ages, Sexes and Conditions.
In every Stage of theſe Oppreſſions we have petitioned for Redreſs in the moſt humble Terms: Our repeated Petitions have been anſwered only by repeated Injury. A Prince whoſe Character is thus marked by every Act which may define a Tyrant, is unfit to be the Ruler of a free People.
Nor have we been wanting in Attentions to our Britiſh Brethren. We have warned them from Time to Time of Attempts by their Legiſlature to extend an unwarrantable Juriſdiction over us. We have reminded them of the Circumſtances of our Emigration and Settlement here. We have appealed to their native Juſtice and Magnanimity, and we have conjured them by the Ties of our common Kindred to diſavow theſe Uſurpations, which, would inevitably interrupt our Connections and Correſpondence. They too have been deaf to the Voice of Juſtice and of Conſanguinity. We muſt, therefore, acquieſce in the Neceſſity, which denounces our Separation, and hold them, as we hold the reſt of Mankind, Enemies in War, in Peace, Friends.
We, therefore, the Repreſentatives of the UNITED STATES OF AMERICA, in GENERAL CONGRESS, Aſſembled, appealing to the Supreme Judge of the World for the Rectitude of our Intentions, do, in the Name, and by Authority of the good People of theſe Colonies, ſolemnly Publiſh and Declare: That theſe United Colonies are, and of Right ought to be, FREE AND INDEPENDENT STATES; that they are abſolved from all Allegiance to the Britiſh Crown, and that all political Connection between them and the State of Great-Britain, is and ought to be totally diſſolved; and that as FREE AND INDEPENDENT STATES, they have full Power to levy War, conclude Peace, contract Alliances, eſtabliſh Commerce, and to do all other Acts and Things which INDEPENDENT STATES may of right do. And for the ſupport of this Declaration, with a firm Reliance on the Protection of divine Providence, we mutually pledge to each other our Lives, our Fortunes, and our ſacred Honor.

Signed by ORDER *and in* BEHALF *of the* CONGRESS,

JOHN HANCOCK, PRESIDENT.

ATTEST.
CHARLES THOMSON, SECRETARY.

PRINTED BY JOHN DUNLAP.

FAC-SIMILE OF BROADSIDE OF DECLARATION OF INDEPENDENCE, IN LIBRARY OF AMERICAN PHILOSOPHICAL SOCIETY.—REDUCED ONE-HALF.

A DECLARATION

In Congress, July 4, 1776 | A Declaration | by the Representatives of the | United States of America | in General Congress Assembled. | . . . . | Signed by Order and in Behalf of the Congress | John Hancock, President | Attest | Charles Thomson, Secretary | Printed by John Dunlap. |

It measures on the print 16⅛ inches in breadth and 21¾ inches in length. A written indorsement on this copy states that it was found among the papers of David Rittenhouse, and the entry in the Donation Book of its gift to this Society is that on September 19, 1828, Dr. Mease presented to the Library a copy of the "Declaration of Independence of U. States of Am Printed on Parchment with the attestation of Cha^{s}. Thomson. Supposed to be printed at the time of Declaration, 4 July 1776 by Jno. Dunlap & found amn^{g}. the Papers of David Rittenhouse."

It will be recalled that the minutes of July 6, 1776, of the Council of Safety of the Province of Pennsylvania record the receipt of the resolution of the Congress directing the transmittal of the Declaration to the Council, whereupon "letters were wrote to the Counties . . . . Inclosing copy of the said Declaration, requesting the same to be publish'd on Monday next [July 8th]."

Since a single[1] copy only of the Declaration had been transmitted by the President of the Congress, it seems probable that the Council of Safety of the Province of Pennsylvania needed additional copies for transmittal to the various Counties, Committees of Safety, etc., in the Province, just as we shall see hereafter did the Council of Massachusetts, and therefore ordered its printer, John Dunlap, to supply them. The type of the original edition in all probability had not been kept standing when Dunlap received this order and he was therefore obliged to set it up anew. He now saw that the document was one of more than usual importance and had it set up in larger and more imposing type. It seems, too, not unlikely that Dunlap at this time, recognizing the high historical value of this document, printed off a copy or two on vellum for purposes of presentation, and that he gave one of these to David Rittenhouse who was a leading member of the Council of Safety and afterwards its Vice-President.

[1] On this point see *Public Records of the Colony of Connecticut*, Vol. xv, 1775–1776, p. 477: "Letters from the Congress of 6th inst. came in (by express) containing information of their late Declaration of Independence and a copy of it, requesting the same to be duly published, etc."

The inference that this edition was printed early in the month of July, 1776, is strengthened by the wording of the title, which was changed to "the Unanimous Declaration," etc., by resolution of the Congress on July 19, 1776, as we shall see more particularly hereafter.

This edition, as regards typography, is beyond comparison the finest of the contemporaneous broadsides of the Declaration. It is fac-similed, reduced in size about one-half, in the accompanying plate (Plate V).

In the *Du Simitière's Scraps*, 1771–1810, in the Philadelphia Library (960 and 962 F), there is another contemporaneous broadside of the Declaration which is also unnoted in the bibliographies. It does not bear any imprint. It measures on the print 10⅞ inches in breadth and 11¼ inches in length. It is in double column, separated by two parallel rules, and at the bottom of the second column it has the printed signature and attestation of John Hancock and Charles Thomson in the same form as in the previous editions noted.

The line for line transcript of the head lines is as follows:

In Congress, July 4, 1776 | A Declaration by the Representatives of the United States | of America, in General Congress assembled | . . . .

With the kind assistance of Mr. Charles R. Hildeburn, I endeavored to identify the printer of this broadside by means of the types used, but without success, although Mr. Hildeburn is strongly inclined to believe that it is a Philadelphia imprint.

John Gill and Powars and Willis, of Boston, jointly appear to have struck off two editions of the Declaration, one without and the other with their imprint. Copies of both of these are in the library of the Massachusetts Historical Society. Neither of them is given in Mr. Ford's *Bibliography*.

John Gill was the publisher of the *Continental Journal*, and Dr. Green writes me that this broadside "was undoubtedly printed in July, 1776, as a copy in finer type appears in his paper of July 18. Powars and Willis were also publishers of another paper, the *New England Chronicle*, in Queen Street." The edition without their imprint, Dr. Green informs me, "was struck from the same form [as the one with their imprint] with the texts of the same dimen-

sions and the heading with fewer leads." It seems to me most probable that the edition without their imprint was struck off first, and then finding that there was a demand for the broadside they struck off another edition, to which they added their imprint and improved its appearance by inserting additional leads between the head lines.

The edition without their imprint is in double column and measures on the print 11⅛ inches in breadth by 15⅝ inches in length. A copy of it is to be found in the library of the Massachusetts Historical Society, and of the Essex Institute at Salem. It is reproduced in facsimile in Bryant and Gay's *Popular History of the United States*, New York, 1879, Vol. iii, p. 482.

The other edition, with the added imprint of John Gill and Powars and Willis, is reproduced in facsimile in Winsor's *Narrative and Critical History of America*, Vol. vi, p. 267. It is likewise in double column and measures on the print 11⅜ inches in breadth by 17⅝ inches in length. The line for line transcript of the head lines and colophon is as follows:

In Congress, July 4, 1776 | A Declaration | by the Representatives of the | United States of America; | In General Congress Assembled. | . . . . | America: Boston, Printed by John Gill, and Powars and Willis, in Queen Street.

A peculiarity of the Gill and Powars and Willis editions is that in the attestation Charles Thomson's name is spelt with a "p."

A contemporaneous edition was also printed by E. Russell at Salem, in Massachusetts, which corresponds with Ford's No. 103, and of which torn and imperfect copies are in the Emmet Collection, in the New York Public Library (EM. 1532) and in the Library of the Massachusetts Historical Society. Dr. Green informs me that this broadside measures on the print 12⅝ inches in breadth by 18⅞ inches in length.

The line for line transcript of the head lines and colophon of this edition is as follows:

In | Congress, | July 4, 1776 | A Declaration | by the | Representatives | of the | United States of America, | In General Congress Assembled. | . . . . | Salem, Massachusetts-Bay: Printed by E. Russell; by Order [torn].

Dr. Green writes me that in the copy of this broadside possessed by the Massachusetts Historical Society "the Declaration is followed by an Order, in six lines, attested by 'John Avery D' [torn]." "The tear in the lower right-hand corner takes up one-half of the width of the broadside, and about one-quarter of its length." The order is that of the Council of Massachusetts, dated July 17, 1776, directing that the Declaration of Independence be printed, and that the minister of each parish read the same on the ensuing Sunday. John Avery, who signed this order, was the Deputy Secretary of the Council of Massachusetts, and in a letter to Sheriff Greenleaf, dated "Council Chamber, August 5, 1776," he says: "I am directed by the honorable Committee of Council to acquaint you that the printed Declarations of Independency are on their table, and they expect that you will take proper care that they be distributed through this State as soon as may be, that every town may have them publicly read in each religious assembly" (*Am. Archives*, 5th Series, Vol. i, p. 778).

Mr. Ford gives as No. 104 of his "Bibliography" an edition of which I have been unable to locate a copy. He states that it measures 15 inches x 19½ inches. The line for line transcript he gives as follows:

In Congress, July 4, 1776, | Declaration | By the Representatives of the | United States of America | In General Congress Assembled

Mr. Ford writes me that he cannot now recall where he saw this broadside, but his impression is that it was at an auction in Boston some eight or nine years ago and that he made the memorandum concerning it at that time.

The *Journals of Congress* state (Vol. ii, Phila., 1776, p. 241) that "the Declaration being read, was agreed to, as follows:

"A Declaration by the Representatives of the United States of America in Congress assembled." It will be noticed that in the first editions previously referred to the word "general" has been interpolated before "Congress" in the title, so as to read, "in General Congress assembled," and in Dunlap's second edition and the others prior to the Baltimore edition of the following year the interpolation is retained. For this alteration in the title to the

Declaration I can find no authority in the printed *Journal* of the Congress.

On July 19, 1776, the Congress "*Resolved*, That the Declaration passed on the 4th be fairly engrossed on parchment, with the title and style of—"The Unanimous Declaration of the 'Thirteen United States of America;' and that the same, when engrossed, be signed by every member of Congress" (*Secret Journals of the Acts and Proceedings of Congress*, Vol. i, Boston, 1821, p. 48), and on August 2, the *Secret Journal* states that, "The Declaration of Independence being engrossed, and compared at the table, was signed by the members."

On January 18, 1777, the Congress "*Ordered*, That an authenticated copy of the declaration of independency, with the names of the members of Congress, subscribing the same, be sent to each of the United States, and that they be desired to have the same put upon record" (*Journal of Congress*, Vol. iii, Philadelphia: John Dunlap, p. 28).

The next official edition of the Declaration was printed under the above resolution at Baltimore, whither the Congress had adjourned from Philadelphia on December 12, 1776 because of the advance of the British troops and their subsequent occupation of that city. Copies of this edition are to be found in the Emmet Collection in the New York Public Library (EM. 1535) and in the Boston Public Library. It corresponds with No. 105 of Mr. Ford's Bibliography. This broadside measures on the print 12¼ inches in breadth by 19⅝ inches in length and is facsimiled in *The Orderly Book of Sir John Johnson*, Albany, 1882, p. 220. The line for line transcript of the head lines and colophon are as follows:

In Congress, July 4, 1776, | The Unanimous | Declaration | of the | Thirteen United States of America |

The text is printed in double columns, and the signatures of the members are appended, with that of John Hancock in the centre of the top line and the others being arranged beneath in four parallel columns, the members signing by States, with Georgia first. Their signatures are included in a bracket placed to the left with the name of the State they represent opposite. Then follows the text of the resolution of January 18, 1777, and signed

By order of Congress | John Hancock, President |

Then in manuscript is written on the copy fac-similed in the *Johnson Orderly Book*:

Attest: Chas. Thomson, Sec'y. | A True Copy | John Hancock, Presid't. |

The colophon is:

Baltimore, in Maryland: Printed by Mary Katharine Goddard |

A very valuable bibliography of the literature pertaining to the Declaration, including its signers, signing and promulgation, prepared by Mr. Wilberforce Eames, the accomplished Librarian of the Lenox Library, is to be found in the *New York Public Library Bulletin*, Vol. i, December, 1897, pp. 351, 352.

DIVISIONS OF THE SOUTH AUSTRALIAN ABORIGINES.

WITH MAP.

(Plate VI.)

BY R. H. MATHEWS, L.S.

(*Read January 19, 1900.*)

The territory dealt with in the following pages comprises approximately that part of the province of South Australia situated east of the 132d meridian of longitude and south of the 24th parallel of latitude, but is more particularly delineated on the accompanying map. All the native tribes within this immense region are divided into two intermarrying phratries, with the exception of some tribes on the Murray river and Yorke's peninsula, among whom no well-defined divisional system has been reported.

I shall endeavor in this article to determine the boundaries of the country occupied by certain aggregates of tribes possessing the same divisional names and practicing similar initiatory rites, which it is proposed to denominate nations, following the method adopted by me in showing the distribution of the native tribes of New South Wales,[1] Victoria[2] and Queensland.[3] A map is added, on

[1] PROC. AMER. PHILOS. SOC. PHILADA., xxxvii, 54–73, Plate v.

[2] *American Anthropologist*, Washington, xi, 325–343, Plate v.

[3] PROC. AMER. PHILOS. SOC. PHILADA., xxxvii, 327–336, Plate xiii.

which is marked the geographic range of each nation and defining also the limits within which circumcision and subincision are in force.

I. The Parnkalla Nation.

In 1846 the Rev. C. W. Schürmann published a pamphlet on the *Aboriginal Tribes of Port Lincoln, South Australia*, in which, on p. 9, he stated that the Parnkalla tribe was "divided into two distinct classes, the Mattiri and Karraru people. . . . . If a husband be Mattiri, his wife must be Karraru, and *vice versa*, the children taking invariably the appellation of that class to which their mother belongs." This is the first accurate record of the divisions of aboriginal tribes, not only in the colony mentioned, but in any part of the Australian continent. Owing to this priority and for convenience of reference I have adopted the name of the Parnkalla tribe for the whole nation. I shall endeavor to give the names and territorial limits of a few of the most important of the many tribes of which this large nation is composed.

The Rev. Mr. Schürmann says[1] the Parnkalla language extended "from Port Lincoln probably as far as the head of Spencer's Gulf," which would be about where Port Augusta now stands, and that "northeast of the Parnkalla was the Nukunna tribe." The Nauo, or Nowo, tribe adjoined the Parnkalla on the west[2] and inhabited the country from Venus Bay to Koppawanata station. Northwest of the Nauo, around Yardea station, was the country of the Willeuroo tribe. The Parnkalla, Nauoand Willeuroo, were practically the same people in language and customs, and are included in the same nation on the map. I am informed by old residents that a small tribe called Kooapudna was formerly located around Franklin Harbor. These people are not mentioned by Mr. Schürmann.

Mr. B. Hack states that a tribe, which he calls Noocoona, occupied the eastern side of Spencer's Gulf, from Port Augusta to Bundalear (see map) and extended east to Coonatto.[3] As the Noocoona of Mr. Hack were located in the country indicated by Mr. Schürmann as being inhabited by the Nukunna, it seems safe to infer that both writers meant the same people; for although the spelling is different the pronunciation is substantially the same.

[1] *Native Tribes of South Australia* (1879), p. 249.
[2] *Ibid.*, p. 249.
[3] *Folklore, Manners, etc., S. A. Aborigines* (1879), pp. 64–66.

Mr. Noble, a police trooper, in describing the customs of the Alury tribe of the Flinders Range,[1] says they were divided into "two clans," called Muttay and Arriee, which I have assumed are intended to represent Mattiri and Karraru of the Parnkalla divisions. Mr. Noble includes "Crystal Brook and surrounding country" in his description, which would overlap and include the territory of the Noocoona tribe above referred to. This suggests the inference that the Alury and Noocoona were subtribes of the same people.

The Kooyeeunna and some smaller allied tribes occupy the country from South Lake Eyre, including Turret Range, Chambers creek, Screech-Owl creek, and others, to Lake Torrens, and southerly along its eastern shore as far as Nilpena station, where they adjoin the Alury already mentioned. A friend of mine who resided a long time on Willochra creek, in the heart of the country occupied by the Alury tribe, says their proper name is Eeleeree. He states that they are divided into the two groups, Mattiri and Karraru, like the Hillary people, who are their near neighbors on the western side of Lake Torrens. Both tribes circumcise and split the penis of the youths, and their language has many words in common. The Kooyeeunna extend northeasterly to meet the Dieyerie; and on the southeast they are joined by the Kutchnamootha and friendly tribes, who are spread over the district from Mount Freeling to Lake Frome and Lake Blanche.[2] East of the Kutchnamootha is inhabited by the Pulladapa tribe, including the country adjacent to Lake Callabonna, and thence toward the New South Wales boundary.

Adjoining the Kooyeeunna and Kutchnamootha, and reaching northerly, beyond Cooper's creek, is the territory of the Dieyerie tribes. Their eastern boundary is approximately a line drawn from Mount Freeling, through Lakes Blanche and Hope, to Lake Perigundi.[3] From the debouchure of the Diamantina river into Lake Eyre, up that river to Goyder's Lagoon, taking in Kalamurina, Cowarie, Mungarane and Berlino stations, is inhabited by the Ahminnie tribe. Beyond the Ahminnie is the Wonka-

[1] *Folklore, Manners, etc., S. A. Aborigines* (1879), p. 64.

[2] Mr. E. M. Curr, in his book, *The Australian Race* (1886), refers to these two tribes, whom he calls Cooyiannie and Kudnamietha. Vol. ii, p. 118.

[3] Compare with description given by S. Gason in his *Dieyerie Tribes of Aus. Aborigines* (1874), p. 11.

oora tribe, occupying the country from Macumba river nearly to Alton Downs. The southern end of their country is watered by the Macumba river and the lower portion of Kallakoopa creek. North of the Wonkaoora is the Wonkamudla tribe, reaching from Alton Downs to Annandale and other stations.

The Wonkaoora and Wonkamudla tribes extend a long way to the northwest into the desert country, consisting of sandhills, with sterile patches and salt marshes between them. The only water in this tract is obtained from native wells, called *mickeries*, and the natives of that district are on this account known as "the mickerie blacks." These wells are for the greater number shallow holes, little more than "soakages," and generally contain only small supplies of water, but a few of them are as much as twenty feet deep, or more, being wide at the top and tapering almost to a point at the bottom, into which the water percolates through the loose strata.

Adjoining the Wonkaoora on the southwest are the Arrabunna people, who inhabit the country from near the Macumba southerly along the western side of Lake Eyre as far as Margaret creek, where they adjoin the Kooyeeunna tribe already mentioned. The Arrabunna extend up the Neale and Peake creeks till met by the Andigarina people; toward the southwest they reach to Stuart's Range, where they adjoin the outposts of the Kookatha nation. Touching the Kooyeeunna about Red Lake, and extending thence southerly down the western side of Lake Torrens is occupied by the remnants of the Hillary, Kakarrura, Yallingarra and other friendly tribes, meeting the northern limit of the Parnkalla and Nauo before referred to. I propose calling this tract of country the Hillary Nation, after the Hillary tribe, mentioned by Mr. J. Bryant in 1879.[1]

In all the principal tribes or aggregates of subtribes and families, whose boundaries are outlined in the preceding pages and enumerated on the appended map as 1 to 10, the people are bisected into the phratries, Matturri and Kirraroo,[2] the men of the one marrying the women of the other. No previous writer has attempted to define the geographic distribution of all the people possessing this organization, and show the correct relative location of each tribe on a map of South Australia. The collection of

[1] *Folklore, Manners, etc., S. A. Aborigines* (1879), p. 103.

[2] I have adopted these forms of the Phratry names, because they are used by the Kooyeeunna tribe, who are located near the centre of the nation.

reliable data, from which to prepare such a map, has been the result of long and patient inquiry extending over some years.

The following synopsis shows how the two phratries intermarry and the descent of the resulting offspring:

TABLE NO. 1.

Phratry.	*Husband.*	*Wife.*	*Offspring.*
A	Kirraroo,	Matturri,	Matturri.
B	Matturri,	Kirraroo,	Kirraroo.

All the people, men and women alike, bear the name of an animal or some other natural object, which is their totem. I have noticed that certain totems which belong to one phratry in a given district are found to belong to the other phratry among the members of a tribe occupying a different part of the country. Similar differences have been observed by me among the native tribes of New South Wales, Queensland and Victoria. Therefore, in supplying a few lists of some of the totems attached to the two phratries—Kirraroo and Matturri—the name of the tribe will be mentioned in each case. I will take the totems of the Arrabunna tribe first.

The undermentioned totemic names may be enumerated as some of those belonging to the people comprising the Kirraroo group:

Emu,	Rainbow,	Diver,
Mopoke,	Scrub Turkey,	Bull-dog Ant;
Fish,	Gum Tree,	Crane,
Common Fly,	Top-knot Pigeon,	Moon,
Sun,	Clouds,	Sandalwood Tree,
Rain,	Lightning,	Barley Grass,
North Wind,	Thunder,	Acacia,
Nardoo,	Crow,	Carpet Snake,
Hailstones,	Opossum,	Spoonbill,
Box Tree,	Pelican,	Beefwood Tree,
Needle Bush,	Mimosa,	Green Snake.

Among the totems of the people constituting the Matturri group may be mentioned the following:

Wild Dog,	Eagle Hawk,	Small Lizard,
Spider,	Common Magpie,	Brown Snake,
Curlew,	Black Duck,	Whip Snake,
Swan,	Frog,	Kangaroo Rat,
Grasshopper,	South Wind,	Wattle Tree,
Quandong Tree,	Shag,	Ring-neck Parrot,
Iguana,	Quartz Stone,	Mulga Tree.
Plain Turkey,		

II. The Yowerawarrika Nation.

The Yowerawarrika tribe adjoin the Dieyerie Ahminnie, Wonkaoora and Wonkamudla on the east, and reach northerly and easterly into Queensland. Their territory includes Coongie, Clifton Hills, Pandy Pandy and Cordilla Downs. Adjoining the Yowerawarrika on the south are the Yanderawantha, who reach from Patchawarra creek southerly across the Cooper and down the Strzelecki creek till they meet the northern limit of the Pilladapa about Lake Callabonna. On the west they are bounded by the Dieyerie, and on the east they extend within the Queensland and New South Wales frontier. Innamincka, Tinga Tingana, Kanowinna, Oontoo and other stations, are situated within the territory of this tribe.

The social organization of the Yowerawarrika and Yanderawantha consists of two intermarrying phratries called Koolpirro and Thinnawa; a Koolpirro man marries a Thinnawa woman, and, *vice versa*, the sons and daughters of the marriage taking the name of the group to which the mother belongs. Arranged in tabular form these rules of marriage and descent appear as follows:

Table No. 2.

Phratry.	*Husband.*	*Wife.*	*Offspring.*
A	Koolpirro,	Thinnawa,	Thinnawa.
B	Thinnawa,	Koolpirro,	Koolpirro.

There is a collection of totems attached to each phratry. The following are some of the totems of the Koolpirro people:

Carpet Snake,	Rainbow,	Rat,
Red Ochre,	Pigface,	Native Companion,
Crow,	Emu,	Curlew.
Kite-hawk,	Pituri.	

The Thinnawa division claims the undermentioned animals and objects amongst others :

Iguana,	Eaglehawk,	Plain Turkey,
Bull-Frog,	Shag,	Black Duck,
Jew Lizard,	Dingo,	Plover,
Witchetty,	Native Cat,	Crane,
Ground Frog,	Kangaroo Rat,	Diver.
Water Rat,		

The phratry name Koolpirro is the equivalent of Kirraroo, and Thinnawa corresponds to Matturri of the Parnkalla organization. Koolpirro is likewise equivalent to the pair of sections Woongo and Koobaroo, and Thinnawa to the pair, Bunburri and Koorgilla, of the tribes adjoining them on the northeast.

III. The Barkunjee Nation.

The divisional system and initiation ceremonies of the tribes constituting this nation have been fully reported in my paper published in the *Journal of the Royal Society of New South Wales*, Vol. xxxii, pp. 240–255.

IV. The Adjadurah Nation.

The Adjadurah tribe occupied Yorke Peninsula, a long tongue of land lying between St. Vincent and Spencer Gulfs and reaching north as far as Crystal brook. Mr. McEntire says these natives were more similar to the Adelaide tribe than any other; and Mr. E. M. Curr states that the language of the Adelaide blacks resembled that of those occupying Yorke Peninsula more than the language of the natives of the Murray river. I have compiled the following comparative vocabulary of twenty-four words used by both tribes, selected from four different authors—Teichelmann and Schürmann,[1] Edward Stevens,[2] E. McEntire[3] and E. M. Curr.[4]

[1] *Grammar and Vocabulary of Aboriginal Language Spoken by Natives of Adelaide* (1840), pp. 1–176.

[2] *Jour. Roy. Soc. N. S. Wales*, xxiii, 498–501.

[3] *Folklore, Manners, etc., S. A. Aborigines* (1879), p. 63.

[4] *The Australian Race* (1886), ii, 146, 147.

English.	Teich. and Sch. Adelaide.	E. Stevens. Adelaide.	E. McEntire. Y. Peninsula.	E. M. Curr. Y. Peninsula.
Kangaroo	Nanto	.....	Munthu	Nantoo
Opossum	Pilta	Pilta	.....	Bilta
Dog	Kadli	Cudlee	Kuddelee	Kadle
Emu	Kari	Curree	.....	Garrie
Crow	Kua	.....	.....	Gooa
Swan	Kudlyo	.....	.....	Guldyoo
Fish	Kuya	Cooyar	Kooya	Guya
Egg	Muka	.....	.....	Mokka
Head	Makarta	.....	Kukaa	Kakka
Nose	Mudla	Meedla	Mudla	Mudla
Eye	Mena	Meena	Midna	Minni
Teeth	Tia	.....	Teeya	Tea
Hand	Marra	Moora	Murra	Mirra
Foot	Tidna	Tidna	Thidna	Didna
Breasts (female)	Ngammi	Umme	.....	Ammie
Blood	Karro	.....	Gerra	Garro
Excrement	Kudna	.....	.....	Goodnarie
Reed Spear	Kaya	.....	.....	Giea
Fire	Gadla	.....	Kudla	Gurdla
Smoke	Puiyu	.....	.....	Booyoo
Sun	Tindo	Tindoo	Deento	Tintoo
Moon	Kakirra *or* Piki	Cackera	Bigha	Birra
Star	Purle	.....	Boorlee	Burlie
Die *or* Dead	.....	Moorloona	Barloona	Barluna

Besides the affinity of their speech, the Yorke Peninsula and Adelaide natives had many customs in common. Mr. E. M. Curr, Mr. E. McEntire and Mr. T. M. Sutton report that circumcision was practiced on Yorke Peninsula, and the last-named author mentions the use of a bullroarer.[1]

Teichelmann and Schürmann state that in the Adelaide tribe a youth was called *Pappa* after being circumcised; *Turlo* was the name of the circumcisor; and the being who first taught the rite to their ancestors was named *Yura*, who also punished those who neglected to carry it out. He further says that a bullroarer called *Kadnamangutta* was employed in the ceremony. It was a thin, oval piece of wood, five inches long and an inch and a half wide, tied to a

[1] *Proc. Roy. Geog. Soc., S. A. Bch.*, Vol ii, 3d series, p. 17.

string, by which the natives swung it rapidly round, causing a humming noise. Females and children were not allowed to see it.

Mr. G. F. Angas reports that circumcision was in vogue among the Wirramayo tribe, who occupied the vast scrub country to the northwest of the river Murray, and that an instrument called *Wittoo Wittoo*, an oval piece of wood fastened to a string of human hair, was whirled round with great rapidity, producing a loud, roaring sound.[1]

Owing to the similarity of the dialects of the Yorke Peninsula and Adelaide tribes, the prevalence of circumcision and other customs, together with the fact of their being adjoining neighbors, seems to me to justify the assumption that they were practically the same people. I have therefore included these two tribes in one nation. Mr. McEntire and Mr. Sutton say that in the Yorke Peninsula tribe the children followed the father. Having read all that both these writers have to say on the subject, I am nevertheless of opinion that the descent of the children depended directly on the mother, being led to this conclusion by inquiries I have made from old residents of that part of the country and from natives of adjacent tribes. Whether or not they were divided into two intermarrying phratries, like the nations to the north and west of them, appears to have escaped the notice of early investigators.

V. The Narrinyeri Nation.

The tribes composing this nation have been dealt with in my article on "The Victorian Aborigines,"[2] so that a brief reference will be sufficient in the present treatise. Their territory was chiefly in South Australia, but extended a little way into the adjoining colonies of New South Wales and Victoria. Their southern limit was Lacepede Bay, whence they reached along the coast to Cape Jervis and up the Murray river almost to the junction of the Darling (see map). They did not practise circumcision, and their language differed from that of their neighbors. The Rev. G. Taplin, who is the most experienced of the early writers on the customs of these people, gives no group divisions, and says descent was counted through the father.[3] In the Barkunjee and Booandik tribes, who

[1] *Savage Life in Australia and New Zealand*, Vol. i, p. 99.

[2] *American Anthropologist* (Washington), xi, 336–343.

[3] *Folklore, Manners, etc., S. A. Aborigines* (Adelaide, 1879), p. 157.

adjoin the Narrinyeri, the descent is on the mother's side, although they marry into the phratry of the father, and the children are brought up in his tribe.

VI. The Booandik Nation.

More than three-fourths of the entire area of this nation is situated on the other side of the boundary between South Australia and Victoria, and their social organization has been described in my paper on the aborigines of the latter colony.[1] I wish to repeat here, however, that the community is divided into two intermarrying phratries, called Krokitch and Kamatch. If a man belongs to the Krokitch division his wife must be taken from among the Kamatch people, and *vice versa*—the children taking the name of the phratry to which their mother belongs.

VII. The Kookatha Nation.

Lying to the west of the Parnkalla, Hillary and Arrabunna Nations, the country is occupied by several tribes, including the Kookatha, Geebera, Wirrunga, Yilrea, Warnabinnie and some others. This aggregate of people will be designated the Kookatha Nation, and the following is a brief outline of the geographic distribution of the different tribes composing it.

The Kookatha tribe extends from the Stuart Range, taking in Lake Phillipson, Mount Eba Station, Wilgena Station, Mount Finke and Lake Bring. The Geebera people are on the north of Lake Gairdner. Between the Gawler ranges and the head of the Great Australian Bight we encounter the Wirrunga, Yilrea, Warnabinnie and other tribes, inhabiting the coastal districts. The people of the interior are more friendly among themselves than with the coast people, and speak a slightly different dialect. They all mix together, however, in their great corrobories, and have similar ceremonies of circumcision, subincision and the enlargement of the vaginal orifice. The coast tribes do not extract a front tooth from the upper jaw of the males, but this custom prevails all over the back country.

In the Geebera tribe, and for a long way westward of them, the two intermarrying phratries are designated Kookoojiba and Koocheebinga, and the resulting offspring take the name of their

[1] *American Anthropologist*, xi, 331–336.

mother's phratry, which may be exemplified in tabular form as under:

TABLE No. 3.

Phratry.	*Husband.*	*Wife.*	*Offspring.*
A	Kookoojiba,	Koocheebinga,	Koocheebinga.
B	Koocheebinga,	Kookoojiba,	Kookoojiba.

Among the coastal tribes, in order to prevent consanguineous marriages, the chief old men appoint certain women to be *uumrée* to certain young men, and the men thus selected are also *uumree* to these women. This can be illustrated by supposing that a woman who is *uumree* to a certain man has a son and a daughter. The man, who may be called A, who is also *uumree* to her, takes her daughter as his wife, and if he himself has a sister he is supposed to give her to the woman's son, who would, of course, be his wife's brother. Then the man A and his wife's brother would become what the natives call *maratho,* which signifies that they must always assist one another in time of danger. A man and woman who are *uumree,* therefore, stand in the relationship of son-in-law and mother-in-law. They never speak to one another as long as they live, and avoid looking at each other if possible, yet remaining the best of friends.

Female children are betrothed in their infancy to such of the males as may be entitled to claim them as their wives in accordance with the laws of the tribe. A man is supposed to contribute something in the way of food to his future wife, until she is old enough to go and cohabit with him.

Where the law permits, women who have very dark hair and complexions are appointed *uumree* to men whose complexions and hair are lighter, and *vice versa.* This distinction in the color is also apparent in the betrothals, a lighter girl being betrothed to a darker boy, and a darker girl to a lighter boy. In all cases, however, the parties who are *uumree,* and also those who are betrothed, must belong to opposite phratries.[1]

The tribes who adjoin the Kookatha nation on the west are substantially the same people in language and customs, and extend onwards into western Australia. Commencing about Israelite Bay

[1] The Parnkalla divisions, Kirraroo and Matturri, are known at least as far west as Murat Bay, owing to the intermarriage of the people of the two nations.

and extending a considerable distance westerly and northerly along the coast of western Australia, the tribes are divided into two intermarrying phratries[1] called Munnichmat and Wartungmat, with groups of totems attached to each, particulars of which will be given in another article.

VIII. The Andigarina Nation.

Bounding the Arrabunna on the northwest are the Andigarina and friendly tribes, occupying the country up the Alberga river to the Musgrave range, and onward to the Petermann ranges and Lake Amadeus, where they meet the Loorudgee tribe. The Andigarina and Loorudgee are divided into four sections, called Koomara, Panungka, Bultara and Parulla, particulars of whose intermarriages have been dealt with by me elsewhere.[2] This organization, with some modifications in the names of the sections, and in the order of their intermarriage, extends westward across the colony of western Australia to the Indian Ocean.[3]

Lying northward of the Andigarina, and adjoining also the Wonkaoora and Wankamudla referred to in a previous page, is the Arrinda tribe, occupying the country at Macumba, Dalhousie, Charlotte Waters and the Lower Finke river, and stretching northeasterly a considerable distance. They have the same four sections as the Andigarina, and their rules of intermarriage and descent are identical. The Arrinda and Andigarina people have a similar language.

Northeasterly of the Arrinda are the Yorrawinga and friendly tribes, located on the Field, Woodroffe and Georgina rivers. They

[1] Divisions on the same principle, but differing in the names of the phratries, are also found on the northeast coast of Queensland, between Cardwell and Cape Melville. In some places the names are Koorabunna and Kooragoola—in others Darboo and Tooar—in others Chunna and Jaypar, and so on.

[2] Proc. Amer. Philos. Soc. Phila., xxxviii, 79.

[3] Among the Weedokarry tribe in western Australia, the following table shows he names of the four sections and their rules of intermarriage and descent:

Phratry.	*Husband.*	*Wife.*	*Offspring.*
A	Butcharrie,	Burronga,	Banaka.
	Kurrimurra,	Banaka,	Burronga.
B	Burronga,	Butcharrie,	Kurrimurra.
	Banaka,	Kurrimurra,	Butcharrie.

have four intermarrying divisions named as follow: Koomara, Belthara, Gaballa and Deringera.

Adjoining, but farther to the northward than the Andigarina, Loorudgee, Arrinda and Yorrawinga people, are a number of tribes who are distinguished by having eight intermarrying divisions, instead of two, or four, as in the communities herein described. This eight-section organization extends northerly to the Gulf of Carpentaria and Cambridge Gulf, and will be dealt with in another article.

The language spoken by the Arrinda and allied tribes, and reaching a long way into the eight-section system, has been ably studied and explained by the Rev. H. Kempe.[1]

Explanation of the Map.

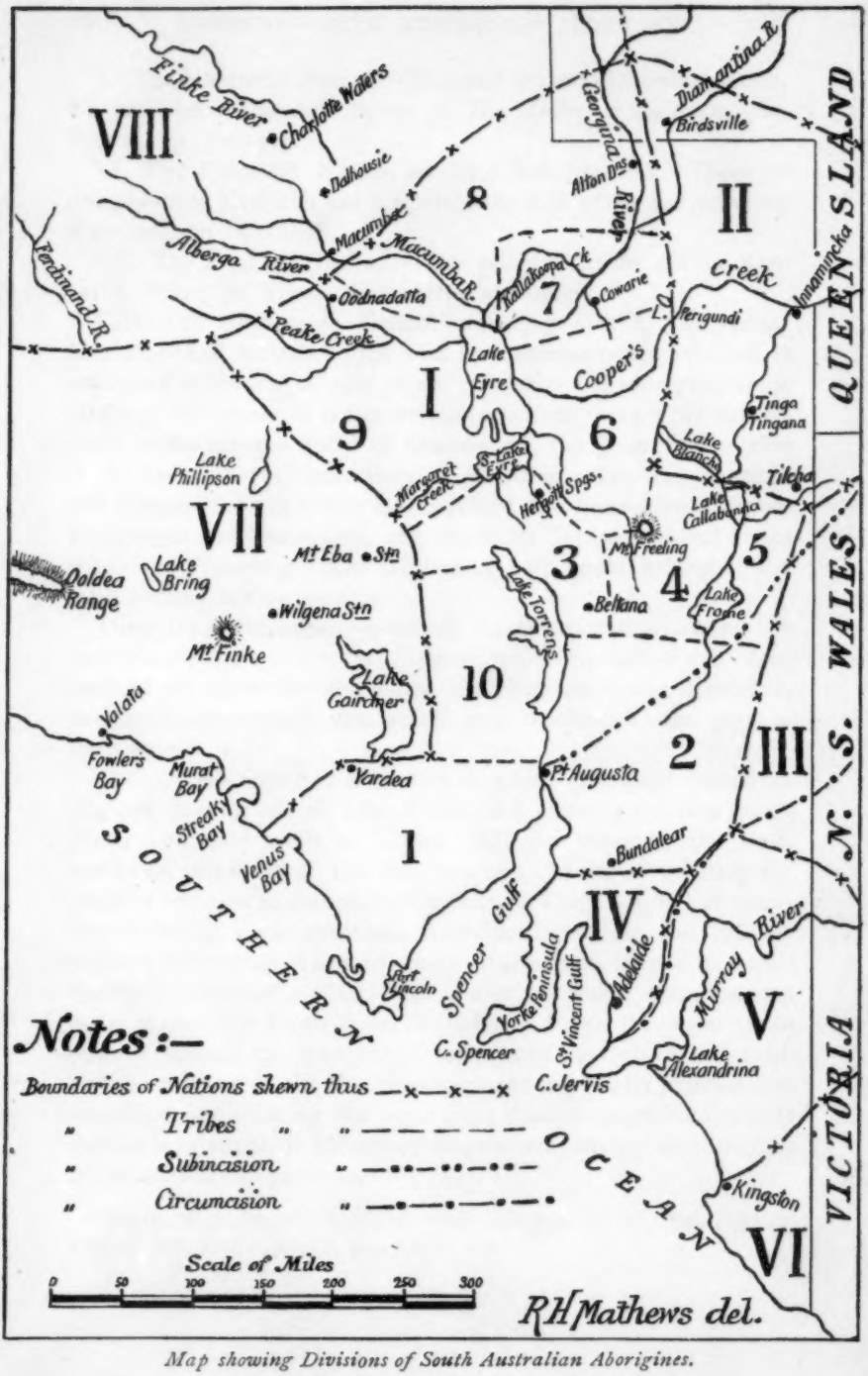
I. The Parnkalla Nation.—This is the largest nation in South Australia, occupying a territory of upwards of 700 miles in length, by a maximum width of 300 miles. In consequence of the immense tract occupied, it has been thought advisable to locate on the map certain communities, consisting of one or more of the tribes constituting the nation. These communities are represented as Nos. 1 to 10 on the map, and are all divided into the two phratries, Matturri and Kirraroo, already explained. The names of some of the principal tribes in each community are as follow: No. 1, Parnkalla, Nauo, Willewroo and Kooapidna tribes. No. 2, Nookoona and Eeleeree. No. 3, Kooyeeunna and others. No. 4, Kutchnamootha. No. 5, Pilladapa. No. 6, Dieyerie. No. 7, Ahminie. No. 8, Wonkaoora and Wonkamudla. No. 9, Arrabunna. No. 10, Hillary, Kakarraru and Yallingarra tribes.

II. The Yowerawarrika Nation.—The principal tribes composing this nation are the Yowerawarrika, Yandrawontha, Wonkamurra, Mullinchie, Kullally and others.

III. The Barkunjee Nation, extending into New South Wales, has two intermarrying phratries, Muckwarra and Keelparra, and the offspring belong to their mother's division.

IV. The Adjadura Nation, comprising the tribes on Yorke Peninsula and around the district of Adelaide.

[1] "A Grammar and Vocabulary of the Language Spoken by the Aborigines of the MacDonnell Ranges, South Australia," *Trans. Roy. Soc. S. Australia*, Vol. xiv, pp. 1–54.



Map showing Divisions of South Australian Aborigines.

V. The Narrinyeri Nation.—This and the next following nation, VI, have been described by me in *The American Anthropologist*, Vol. xi, pp. 331–343.

VI. The Booandik Nation, reaching into Victoria. There are two phratries, Krokitch and Kamatch, the men of the one marrying the women of the other.

VII. The Kookatha Nation.—The principal tribes are the Kookatha, Wirrunga, Yilrea, Warnabirrie and others.

VIII. The Andigarina Nation, consisting of the Andigarina, Loorudgee and Arrinda tribes, with four intermarrying divisions, as explained in the text of this paper. To show the wide geographic range of this system, it is interesting to notice that on the Batavia river, in the extreme north of Queensland, the Joongoonjee tribe is divided into two intermarrying phratries, called Chamagunda and Gamanutta; the former is subdivided into two sections, named Langename and Namegoore, and the latter into two, called Packwicki and Pamarang. The children of both sexes belong to the same phratry as their mother.

There are no feminine equivalents for these section names, but each phratry has a collection of totems, which the natives call *edeet*, some of which are the emu, dingo, rock, bamboo, wood, crow, fire, kangaroo, carpet-snake, sea, shark, sun, black-duck, rat, pigeon, fresh water.

The reader's attention is invited to a line (see map) from Port Augusta, passing east of Lake Frome and entering the New South Wales boundary south of Tilcha. All the tribes to the west, northwest and north of this line practice the rite of splitting the penis in addition to that of circumcision. There is a belt of country, including Yorke Peninsula, Adelaide, Bundalear, and extending into New South Wales, in which circumcision only is in force; the southeastern limit of this tract is also delineated upon the map as far as the New South Wales boundary. From the latter point onward, through the Australian Continent to the Gulf of Carpentaria, the position of the line separating the tribes who practice circumcision and splitting the penis from those among whom neither custom is in vogue, is defined on maps accompanying contributions by me to different societies.[1]

[1] *Journ. Roy. Soc. N. S. Wales*, xxxii, 240–255, Pl. xii; PROC. AMER. PHILOS. SOC. PHILA., xxxvii, 327–336, Pl. xiii.

Stated Meeting, February 2, 1900.

Present, 28 members.

Vice-President BARKER in the Chair.

A letter was read from Dr. Samuel G. Dixon, presenting, on behalf of a few friends of the late Dr. Joseph Leidy, a portrait of him, by Mr. James L. Wood, copied from that by Mr. Bernard Uhle, in the Academy of Natural Sciences of Philadelphia.

On motion the best thanks of the Society were ordered to be transmitted to Dr. Dixon and the other friends of the late Dr. Leidy, to whom this Society is indebted for this valued gift.

The deaths of Dr. William A. Hammond, Surgeon-General U. S. A., retired, and of S. Dana Greene, of New York, members of the Society, were announced.

Vice-President Barker delivered the Annual Discourse.

Stated Meeting, February 16, 1900.

Present, 21 members.

A letter was read from Mr. R. H. Mathews, mentioning a tour he had recently made amongst the aborigines of western Australia.

The deaths were announced of the Hon. John B. Stallo, at Florence, Italy, and of William Henry Green, D.D., at Princeton, N. J., members of the Society.

Mr. Wilcox exhibited a specimen of andalusite from California, and spoke in regard to the formation of the mineral.

Dr. Morris spoke in relation to the changes of glass in New Mexico and elsewhere, which was discussed by Messrs. Wilcox, Wistar, Greene and Sachse.

The Society then proceeded to the election of members, and the Tellers announced the election of

Thomas George Morton, M.D., of Philadelphia.

William Aldis Wright, LL.D., of Cambridge, England.

The Society was then adjourned by the presiding officer.

Stated Meeting, March 2, 1900.

Vice-President BARKER in the Chair.

Present, 17 members.

Dr. Thomas George Morton and Mr. J. Rodman Paul, newly elected members, were presented to the Chair, and took their seats in the Society.

Letters were received from Dr. Thomas George Morton and Dr. Frederick W. True, acknowledging their election to membership, and accepting the same.

The list of donations to the Library was laid on the table, and thanks were ordered for the same.

The meeting was adjourned by the presiding officer.

Stated Meeting, March 16, 1900.

Vice-President WISTAR in the Chair.

Present, 8 members.

Letters accepting membership in the Society were read from Hugo A. Rennert, Gustav Schlegel, Charles D. Sigsbee and William Aldis Wright.

Letters were also read from the President of the International Congress of Colonial Sociology, to be held at Paris during 1900, and from the Committee of Organization of the International Geological Congress, to be held at Paris in August, 1900, in the latter case inviting the Society to appoint one or more delegates to the Congress.

On motion, the President was authorized to appoint one or more delegates from this Society.

The Librarian reported the receipt of a medal struck in honor of Sir George Stokes on the occasion of his recent anniversary.

He also presented from Sir Richard Tangye an autograph letter of Benjamin Franklin to Samuel Huntingdon, President of Congress.

Communications entitled "Descriptions of Some Vertebrates of the Carboniferous Age," by O. P. Hay, of the American Museum of Natural History, and "Native Tribes of Western Australia," by R. H. Mathews, were presented.

The Society was then adjourned by the presiding officer.

DESCRIPTIONS OF SOME VERTEBRATES OF THE CARBONIFEROUS AGE.

(Plate VII.)

BY O. P. HAY,
OF THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.

(*Read March 16, 1900.*)

The following descriptions are based partly on materials which belong to the United States National Museum, partly on materials collected by members of the United States Geological Survey, and partly on a small but very interesting collection which belongs to Mr. L. E. Daniels, of La Porte, Indiana. In the last-named collection are included several specimens of a fossil fish which probably belongs to Dr. Newberry's *Elonichthys peltigerus* and one specimen of Prof. Cope's *Amphibamus grandiceps*.

A few scales of fishes have also been received for examination from the Peter Redpath Museum, Montreal.

Dittodus latus (Newb.).

Diplodus latus, Newberry, J. S., *Proc. Acad. Nat. Sci. Phila.*, viii, 1856, p. 99; Newberry and Worthen, *Geol. Surv. Illinois*, ii, 1866, p. 59, Pl. iv, Figs. 1–1[e]; Newberry, J. S., *Geol. Surv. Ohio*, i, 1873, Pt. 2, p. 336; *Geol. Surv. Ohio*, ii, 1875, Pt. 2, p. 44, Pl. lviii, Figs. 1–1[b]; Woodward, A. S., *Cat. Foss. Fishes*, Pt. i, 1889, p. 12; Destinez, P., *Ann. Soc. Geol. Belg.*, xxiv, 1898, p. 220.

Dissodus latus, Miller, S. A., *N. Amer. Geol. and Pal.*, 1889, p. 714.

A nodule bearing Mr. Daniels' No. 17, from Mazon Creek, Illinois, had originally enclosed a tooth of this species of Elasmobranch. The tooth itself had been almost wholly dissolved out of

the matrix, so that with a little careful cleaning a mold was obtained, into which wax was pressed and thereby a satisfactory restoration of the tooth obtained. The tooth resembles most closely the figures of the species published in the second volume of the *Geological Survey of Illinois*, Plate iv, Figs. 1–1ᵉ. The height of the longest cusp from the lower surface of the base of the tooth is 20 mm. The edges of the compressed cusps had evidently been serrated. The base is prolonged backward, furnished with a button posteriorly and above, flat on the lower or attached side, and with a downwardly projecting tubercle near its front border.

This species was originally reported by Dr. Newberry from the coal-measures of Linton, Ohio. In 1866 it was announced from the coal-measures of Posey county, Indiana. Mr. A. S. Woodward states that it has been found in Illinois, but he probably so inferred from its being described in the Illinois Geological Survey reports. So far as I am aware, it has not hitherto been known from that State. It furnishes another proof of the close relationships of the faunæ of the Linton and the Mazon creek beds. Destinez, as above cited, has reported the species from Belgium.

Dittodus lucasi, sp. nov.

This species appears to be quite distinct from any described up to this time. The possessor of this tooth has been a fish of considerable size. The height of the longer of the two principal cusps is 18 mm., that of the shorter 15 mm., the measurements being made from the lower surface of the base. The tips are separated by a space of 16 mm. The cusps are compressed and furnished with carinæ on the edges. The latter have not, so far as I can determine, been serrated. The form of the cusps does not differ essentially from those of *D. compressus* (Newb.). Between the main cusps, standing at the very front border of the tooth and projecting farther forward than the main cusp, is a very distinct median cusp. Its height, measured from the lower surface, has been about 7 mm., possibly more. The characteristic feature of the tooth is found in its small base. This, when compared with such a species as *D. latus*, is weak. The width of the base (parallel with the jaw) is 10 mm.; the length (transverse to the jaw) is only 7 mm. On each side of

Fig. 1. Dittodus lucasi.

the midline of the base, on its posterior edge and directed backward, is a tubercle about 2 mm. long. There is no indication of any button. The plane of the main cusps makes an obtuse angle posteriorly with the plane of the lower surface of the base—that is, the main cusps project forward very distinctly. This species bears some resemblance to *D. compressus* (Newb.), but a close comparison with the descriptions and figures of that species makes it evident that it is not the same. Newberry's species had all the denticles, even the median one, distinctly crenulated. The base of *D. lucasi* is evidently of a different pattern. Newberry regarded *D. compressus* as being closely related to *D. latus*, but concluded that it possessed a smaller base, the dimensions being three lines long by two and one-half wide. O. St. John describes and figures the species (*Final Report U. S. Geol. Survey Nebraska*, 1872, p. 240, Pl. iv, Figs. 19ª, 19ᵇ). The base is shown to be narrower than long and to have an obtuse tubercle projecting downward anteriorly. The base of *D. lucasi* is broader than long and possesses no such tubercle.

The iron-stone nodule which furnishes the mold of this tooth bears the United States National Museum's catalogue No. 4338 and also Prof. Cope's symbol, F, 3, it having evidently been in his hands as a part of the Lacoe collection which he described. However, it was not named by Prof. Cope. It is from the coal-measures of Mazon creek, Illinois.

This species is named in honor of Mr. Frederick A. Lucas, Curator of the Department of Comparative Anatomy, United States National Museum.

CLADODUS GIRTYI, sp. nov.

This species, which appears to be distinct from any hitherto described, was collected in the coal-measure deposits of Colorado by Dr. George H. Girty, of the United States Geological Survey, and it is named in his honor. It is represented by a single tooth.

FIG. 2. Cladodus girtyi.

This consists of the base, a large median cusp and two smaller cusps on each side of the median one. Of the lateral cusps, the one on each side next to the main cusp is missing, but the size of these may be inferred from the size of the stumps remaining. They could hardly have been much smaller than the outside cusps. The base has a

width (measured parallel with the jaw) of 15 mm., and a length (measured across the jaw) of 5 mm. The outline of this base is somewhat excavated in front beneath the central cusp, forming a sinus, and projects somewhat both forward and downward just below each first lateral cusp. The central cusp has a height of 12.5 mm., measured from the under side of the base; while the outer cusps, measured in the same way, have a height of 7 mm. The main cusp has, at the base, a width of 4.5 mm. and is of a lanceolate form. It has a sigmoid flexure, the profile being, just above the base, convex in front; just below the tip, concave in front. The outer lateral cusps are straight and rather stout in form. The section of the main cusp is lenticular, or nearly semicircular, the anterior outline being much less convex than the posterior. The edges are trenchant. The anterior face of the main cusp is ornamented by about a dozen sharp costæ, separated by rounded grooves. Of these costæ, the median ones run up three-fourths the way to the tip of the tooth. Those nearer the edges are successively shorter. The posterior face of this cusp is similarly ornamented.

The lateral cusps have a hexagonal section, the sides of the hexagon being concave outwardly. Seen from the front, these cusps each present three sharp costæ separated by broad rounded furrows.

This species resembles in various respects certain other species. *Cladodus gracilis* N. and W., of the coal-measures of Indiana, has the median cusp marked by a few coarse, sharply-prominent striæ, but these are said to be somewhat irregular. The lateral denticles are very long, slender, nearly cylindrical and coarsely striated. *Cladodus intercostatus* St. J. and W., of the upper Burlington deposits of Iowa and Illinois, also possesses certain resemblances. However, the postero-superior surface of the base of that species is said to be "surmounted near the posterior margin by a laterally elongated, narrow, roughened prominence, equal to about half the lateral diameter of the base"; of this I find no indications in *C. girtyi*. The ornamentation of the cusps of the two species is also evidently much different.

It might be supposed that the species here described is more likely to be identical with *C. mortifer* N. and W., a species of the coal-measures of Illinois, Indiana, Iowa, Nebraska and Kansas. But aside from other differences, *C. mortifer* is described and fig-

ured as having a pair of conspicuous pads or bosses on the posterior part of the upper surface of the base. *C. girtyi* shows nothing whatever of this character. The only structure of this kind is the pair of protuberances found on the front of the lower surface of the base. The lateral cusps of *C. mortifer* are also said to possess sharp cutting edges and strong, sharp striæ. Good figures of *C. mortifer* may be found in St. John's paper in Hayden's *Final Report of the Geology of Nebraska*, Pl. iii, Fig. 6, and Pl. vi, Fig. 13; and in the posthumous paper by Dr. Newberry, *Trans. N. Y. Academy of Sciences*, vol. xvi, Pl. xxii, Figs. 2–2[a].

Cladodus occidentalis Leidy also is marked by a pair of bosses on the hinder part of the upper surface of the base. The distinctness of *C. mortifer* from *C. occidentalis* is questionable.

Sagenodus.

In making a study of the scales of this genus I have had, thanks to the generosity of the authorities in charge of the vertebrate collections of the United States National Museum, access to the type specimens of the species described by Prof. E. D. Cope in a posthumous paper published in volume xxxvi of the Proceedings of the American Philosophical Society, in the year 1897. Besides these scales, there are a few others belonging to the National Museum, which were presented, as were Prof. Cope's types, by Mr. Lacoe; but which Prof. Cope seems not to have examined. I have also had the privilege of examining still other specimens of the genus, which had been obtained from Mazon creek, Illinois, by Mr. L. E. Daniels, and which yet belong to his private collection. All these have been carefully studied and compared. The result is that I recognize as valid seven out of the ten species described by Prof. Cope. This writer relied much on the forms of the scales in his identifications of the species; but a close examination of a series of scales will quickly shake one's confidence in the validity of this character. I have examined also the scales on a specimen of the existing *Ceratodus*, with which *Sagenodus* was certainly closely allied, and I find that there is a considerable variation in the forms of the scales on different parts of the body. In the region near the shoulder-girdle they are usually broad and with truncated posterior border; toward the tail the scales are more elongated and pointed. Besides these, the head is covered with a few very large scales which differ in form

from those on the body. I am convinced that we must rely more on the arrangement of the system of nutrient canals found in these scales, and on the sculpture of the surface. The availability of both these characters depends somewhat on the perfection of preservation of the scale, but usually they can be satisfactorily determined.

To the writer it seems highly probable that the fishes of this genus, like their existing relatives, lived in fresh waters, probably in rivers which emptied into the sea in which the Mazon creek deposits were formed.

In such cases, when the fishes died, their bones would be left in the bottom of the rivers where they had lived, while numbers of their scales would be likely to be carried to the sea. This may account for the fact that no portions of the bony skeletons of any of the species has yet been found in the regions of Mazon creek.

If it appears remarkable that even seven species of the genus should be found entombed in one locality, we may suppose that possibly these inhabited as many branches of some great river and therefore were, when living, denizens of widely separated regions.

It may further be said that it is not wholly certain that the species described here as members of *Sagenodus* really belong to that genus. So far as regards ornamentation, none of the scales here called *Sagenodus* much resemble the figure of the scale of the type of the genus (*S. elegans*) given by Hancock and Atthey.[1] However, Fritsch[2] has presented much better figures of the same species, and these appear to possess the generic characters of our specimens.

SAGENODUS OCCIDENTALIS (Newb. & Worth.).

Rhizodus occidentalis, Newberry and Worthen, *Geol. Surv. Illinois*, ii, 1866, p. 19, Fig. 2; *Geol. Surv. Illinois*, iv, 1870, Pl. iv, Fig. 1; Newberry, J. S., *Pal. Fishes N. Amer.*, 1890, p. 192; Miller, S. A., *N. Amer. Geol. and Pal.*, 1889, p. 611, Fig. 1173; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 348 (referred with doubt to *Strepsodus*).

Sagenodus occidentalis, Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 75, in part; Williston, S. W., *Kansas Univ. Quart.*, viii., 1899, p. 177.

[1] *Ann. Mag. Nat. Hist.* (4) vii, 1871, Pl. xiii, Fig. 3.

[2] *Fauna der Gaskohle*, ii, 1888, Pl. lxxx.

Megalichthys occidentalis, Hay, O. P., *Amer. Naturalist*, xxxiii, 1899, p. 787.

Sagenodus browniæ, Cope, E. D., Proc. Amer. Philos. Soc., xxxvi, 1897, p. 81, Pl. i, Fig. 7; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

This species was briefly described by Newberry and Worthen in 1866, as above cited, and was illustrated by a wood-cut. This presented the general characteristics of the scale, but did not show well the system of nutrient canals. The same author's figure of the species published in 1870 also failed to show adequately the canals. In Prof. Cope's posthumous paper of 1897 the species was first referred to *Sagenodus*.

In his synopsis of the species of the genus, on page 76, he says of *S. occidentalis*, "Concentric lines conspicuous; tessellations and radii not conspicuous." By "tessellations" was meant the areas formed by the network of canals, and by "radii" the excessively fine lines which radiate from the central part of the scale toward the free border. However, the conspicuousness both of the canals and of the radiating lines depends much on the character of the fossilization, one or the other being often effaced. This must be taken into account in considering the species. I have before me a specimen (Daniels' No. 13) which has a great resemblance to Newberry and Worthen's original figure. It is, however, proportionately longer, its width being nearly equal to its length, while the figure referred to is somewhat wider than long. The scale is also smaller than that figured by Newberry and Worthen, the length being 33 mm. There is a border of conspicuous concentric lines, and the free border is minutely striated. But there is also a very conspicuous system of nutrient canals. This system consists of one set which start from the centre of growth of the scale and radiate, some toward the attached border of the scale, others toward the free border. An upper area of the scale is occupied by similar canals, which, starting at the upper extremity of the attached border, pass somewhat toward the centre; then, turning again backward and upward, come out on the upper side of the free border. A lower area of the scale is similarly marked. A second set of canals runs approximately at right angles to the set just described and unites them, thus dividing the scale into little areas which are more or less regular parallelograms. In another specimen (Daniels' No. 12) the centre of growth of the scale is

occupied by patch of some size in which the meshwork of the canals is very irregular. In Newberry and Worthen's figure a large portion of the scale is occupied by such an irregular meshwork. This may have been due to imperfections of the scale or to errors of observation. At least, I cannot doubt that the scale before me belongs to the same species as that described by the authors named. The figures presented by the same authors in volume iv of the *Geological Survey of Illinois*, Pl. iv, Fig. 1, show a scale differing from the other considerably in form and ornamentation, yet doubtless belonging to the same species. Here the centrally placed irregular meshwork occupies much less space. The radiating canals are shown, but are not conspicuous; and the fine striæ are not shown at all. In fact, the latter are so fine that they could be truly represented only in an enlarged view of the surface. A very similar scale (Cope's F, 99) has been identified by Prof. Cope (*op. cit.*, p. 77) as *S. occidentalis*, as well as others less perfectly preserved (Cope's F, 19, 20; not F, 1, 2). In these the nutrient canals are present, but represented by very fine lines and thus not conspicuous. The fine striæ, when looked for under a lens, occupy a large portion of the surface of the scale.

If I am correct in my identification of the scale spoken of above as bearing Daniels' No. 13, then I must regard as a synonym of *Sagenodus occidentalis* the scale described and figured by Prof. Cope under the name *Sagenodus browniæ*, as cited above in the synonomy. I find nothing to distinguish it from Daniels' No. 13, except size, and this cannot be considered. The form of the scale is very much like the original figure published by Newberry and Worthen. Prof. Cope mentions *S. occidentalis* in connection with his *S. browniæ*, but states that the areolation of the latter is coarser than in any other species. Prof. Cope's figure of *S. browniæ* is faulty in that it represents the scale too broad.

SAGENODUS QUADRATUS (Newb.).

Rhizodus quadratus, Newberry, J. S., *Geolog. Surv. Ohio*, i, Pt. 2, 1873, p. 343, Pl. xxxix, Fig. 8; *Pal. Fishes N. Amer.*, 1890, p. 192; Lesley, J. P., *Dict. Foss. Penn.*, i, 1899, p. 877; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 262 (*Sagenodus* suggested).

Sagenodus quadratus, Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, pp. 76, 77.

Dr. Newberry, as above cited, described very briefly and figured

somewhat imperfectly this species under the name *Rhizodus quadratus*. Excepting that Mr. Woodward has suggested that the species belongs to *Sagenodus*, no additional information of importance has been published since 1873. Prof. Cope, indeed, mentions the fact that he had in his hands a single scale belonging to the portion of the Lacoe collection described by him and collected at Mazon creek, Illinois, and which he thought might belong to *S. quadratus*.

Dr. Newberry's figure represents well the form of the scale and the system of concentric lines. The system of nutrient canals is, however, very inadequately shown; perhaps they were not well displayed in the specimen figured. In my hands are two scales from Mazon creek (U. S. Nat. Mus. Cat., No. 5429 from Lacoe collection, and Daniels' No. 9) which I have no hesitation in referring to Newberry's *S. quadratus*. These scales have the size and the subquadrate form which characterized the original and also the conspicuous concentric lines of growth. One of these (U. S. Nat. Mus. Cat., No. 4429), looked at casually, shows little more of the system of canals than appear in Newberry's figure. The other specimen displays them with great conspicuousness. This scale differs in size from that of Newberry's figure by only a trifling amount; one of its posterior angles is more rounded off; the attached border is also much rounded; while the free border is slightly concave.

The surface of the scale, for purposes of describing it, may be divided into four fields, viz.: (*a*) an anterior, which includes all anterior to a line drawn across the scale somewhat in front of the centre of growth and therefore occupying the anterior third of the scale; (*b*) a posterior, which is included between lines drawn from the centre of growth to each of the two posterior angles of the scale; (*c*) and (*d*), upper and lower fields which occupy the remainder of the surface. The field (*a*) is occupied by a meshwork of nutrient canals, the cells of which are more or less square, very small near the anterior border, but growing coarser and more irregular near its posterior limit. The triangular field (*b*) is occupied by canals which radiate from the centre of growth to the free border of the scale. These lie close together and are connected at intervals by cross canals. The resulting cells are usually narrow and two to four times as long as wide. The intervals between the radiating canals are filled with very fine striæ which

radiate from the centre of growth, and the observance of which require the use of a lens. The fields (*c*) and (*d*) are occupied by a very few nutrient canals which form a few large cells. The most conspicuous of these canals run from the centre of growth to the upper and lower borders. It is in these two fields that the system of concentric lines is most strongly developed. Another scale (U. S. Nat. Mus., No. 4429) does not display nearly so well the system of nutrient canals, but the remainder of the ornamentation is well shown. A third quadrate scale from the Lacoe collection (U. S. Nat. Mus. Cat., No. 4426) is the largest I have seen, having a length of 94 mm. and a breadth of 62 mm. It has the characters of the species well displayed.

In the portion of the Daniels' collection in my hands for description is another scale (Daniels' No. 8) which is of oval form, 45 mm. long by about 29 mm. wide. The ornamentation, including the network of canals of this scale, is identical with that of the scale I have above described as *S. quadratus*. No character except form will separate the two. Another scale (Daniels' No. 19) has a length of 68 mm., a width of 48 mm., and an oval form. I cannot hesitate to place both of these in *S. quadratus*.

In Prof. Cope's paper already cited, on p. 77, he refers certain scales belonging to the Lacoe collection to *S. occidentalis*, and among them one whose two impressions are labeled F. 1, F. 2.[1] This scale is 40 mm. wide and 50 mm. long. I find few characters which would permit it to be referred to *S. occidentalis*, while most of the characters of *S. quadratus* are present. I have hesitated to place it here because the area, including the centre of growth, which in most specimens is occupied by a rather coarse areolation, is in this scale broken up into an extremely fine meshwork; but the other scales differ among themselves in this respect. In form, the scale is closer to the typical *S. quadratus* than are the other oval forms that I have referred to this species, being proportionally broader and having the anterior and posterior borders more broadly rounded. It is also, as regards form, as far removed from the original specimens of *S. occidentalis* as it is from those of *S. quadratus*.

The scale mentioned by Prof. Cope as probably belonging to *S.*

[1] In the paper referred to, these scales are designated by the symbols "Figs. 1–2, 19–20, 99." This is probably an editorial error for F, 1, 2; 19, 20; 99, which symbols we find on the specimens.

quadratus, but as having an entirely exceptional form, is undoubtedly rightly identified. Its sculpture is in all respects like that of the specimen that I have above somewhat minutely described, except that the centre of growth is filled up with a very fine meshwork of canals. In this respect it resembles the broadly oval scale above mentioned. The scale now being considered has a depth of 38 mm. and a length of only 24 mm. It bears the U. S. National Museum's Cat. No. 4388.

SAGENODUS RETICULATUS (Newb. and Worth.).

Rhizodus reticulatus Newberry and Worthen, *Geol. Sur. Ill.*, 1870, iv, p. 349, Pl. iii, Fig. 9 (not Figs. 13, 14); Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 262 (referred with doubt to *Sagenodus*).

Sagenodus reticulatus Cope, PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 78, Pl. i, Figs. 2, 3; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

Sagenodus magister Cope, PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 81, Pl. i, Fig. 8; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

In the report of the Geological Survey of Illinois, vol. iv, as above cited, Newberry and Worthen described the species *Rhizodus reticulatus* and illustrated it by three figures (Pl. iii, Figs. 9, 13, 14). Prof. Cope, writing in 1897, as cited, concludes that two distinct species were involved in the original description and figures and, judging from the materials before me, I believe that he was correct. Prof. Cope then, as he had an undoubted right to do, restricted Newberry and Worthen's specific name to their Figure 9 and referred the other Figures 13, 14 to his own new species *S. quincunciatus*. It is unfortunate that the figure of the type is such an unsatisfactory one. Prof. Cope's figure of *S. recticulatus* shows quite well its characters. He states that the longitudinal striæ of the distal border are not interrupted by any concentric lines, but the latter are nevertheless present in the specimen that he has figured. The agreement of these scales in form with that figured by Newberry and Worthen (Fig. 9) makes it reasonably certain that they all belong to the same species.

A careful study of Prof. Cope's types of his *S. magister* and comparison of them with the scales which he has identified with *S.*

reticulatus has convinced me that they belong to the same species of fish. A comparison of Prof. Cope's figures of the two alleged species will show that they do not differ greatly in form or in sculpture. *S. reticulatus* as figured has its free extremity considerably narrowed, but another scale identified by Prof. Cope as *S. recticulatus* (U. S. Nat. Mus. No. 4389 = Cope's F, 58) has this extremity narrowed as little as it is in *S. magister*. The scales assigned to the latter name are indeed much larger, but the scales of a young fish are naturally smaller than those of an old and larger one. The system of canals in both lots of scales covers the greater part of the surface with a fine meshwork. Only a patch near the upper border and another near the lower border have the areolation coarser. The coarseness of the areolation on the upper border of Prof. Cope's Figure 2 is exaggerated, those large cells being subdivided by finer canals which are not figured.

This species must not be confounded with that recorded as *Sagenodus reticulatus* Newberry by Mr. A. S. Woodward in his *Catalogue of Fossil Fishes*, Part ii, p. 26, and which was originally described as *Ctenodus reticulatus*.[1] The reference of both *Ctenodus reticulatus* and *Rhizodus reticulatus* to *Sagenodus* makes it necessary that the later described species, *C. reticulatus*, shall receive a new name. It may be called *Sagenodus jugosus*, in allusion to the seven radiating ridges on the crown of the tooth on which the species was based.

SAGENODUS FOLIATUS Cope.

Sagenodus foliatus Cope, E. D., PROC. AMER. PHILOS. SOC., xxvi, 1897, p. 77, Pl. i, Fig. 1; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

The form and the character of the meshwork of nutrient canals are shown in Prof. Cope's figure cited above. That figure, however, presents too conspicuously the system of concentric lines. The striæ which Prof. Cope describes are not indicated in the figure, and indeed could hardly be represented on account of their fineness. These striæ may, with a good lens, be seen to occupy a considerable portion of the surface of the scale. A feature of the network of nutrient canals is that one set of these radiate from the centre to all parts of the border of the scale. They lie close together and are frequently connected by cross canals, so that rows

[1] *Geological Survey of Ohio*, ii, 1875, p. 60.

of nearly square cells run out in all directions from the centre. I have seen no specimens except those described by Prof. Cope (U. S. Nat. Mus. Cat. Nos. 4372, 4394).

SAGENODUS LACOVIANUS Cope.

Sagenodus lacovianus Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 79, Pl. i, Fig. 5; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

Sagenodus conchiolepis Cope, E. D., PROC. AMER. PHILOS. SOC., xxxvi, 1897, p. 79, Pl. i, Fig. 4.

Sagenodus conchiopsis (*conchiolepis*), Williston, S. W., *Kansas Univ. Quart.*, 1899, viii, p. 177.

I regard as identical the two species which Prof. Cope has described and figured as above cited. In form the types differ in that *S. lacovianus* narrows somewhat toward the free margin and is more pointed, while *S. conchiolepis* is slightly wider posteriorly and is more truncated; but nothing can be based on such differences. As regards the ornamentation, I find no differences. The type of *S. conchiolepis* is said to have the tessellated area continued to the edge of the scale, but this depends to a great extent on perfection of preservation, and with a good lens may be observed in places even in the type of *S. lacovianus*. Prof. Cope was mistaken, too, I think, when he said that in the type of *S. lacovianus* there are no concentric lines except one coarse one. A number of others are present, but they require mostly the use of a lens. Prof. Cope stated that the sculpture of *S. conchiolepis*, as in *S. reticulatus*, radiates from near the proximal end. This I regard as an important character. An examination shows that in the types of both *S. lacovianus* and *S. conchiolepis* the centre of growth is at the extreme anterior end of the scale. In one of the specimens (U. S. Nat. Mus. Cat. No. 4391 = Cope's F, 59, 60) which Prof. Cope has identified as *S. reticulatus* a considerable number of growth-lines may be seen sweeping around in front of the centre of growth; so that, where the sculpture is well shown, this character may be employed to distinguish the scales. In the specimen of *S. reticulatus* referred to, the centre of growth is removed from the anterior border of the scale one-fifth the whole length of the scale. In the U. S. Nat. Museum there is another scale (U. S. Nat. Mus. Cat. No. 4384), from the Lacoe collection made at Mazon creek, which is intermediate between the type of *S. conchiolepis* and that of *S.*

lacovianus, so far as sculpture and form are concerned; but the size is but little less than that of the type of *S. lacovianus*.

SAGENODUS QUINCUNCIATUS Cope.

Rhizodus reticulatus, part, Newberry and Worthen, *Geolog. Surv. Illinois*, iv, 1870, p. 349, Pl. iii, Figs. 13, 14; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 262 (referred with doubt to *Sagenodus*).

Sagenodus quincunciatus Cope, E. D., PROC. AMER. PHILOS. SOC. xxxvi, 1897, p. 80, Pl. i, Fig. 6; Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

This species has for its type the scale bearing U. S. Nat. Mus. Cat. No. 4364 = (Cope's F, 39, 40). It must have been a very abundant species in the region of Mazon creek, since besides the five specimens recorded in Prof. Cope's paper, there are in the portion of the Daniels' collection in my hands five additional scales. Four of these resemble so closely those described by Prof. Cope that no mistake can be made in their identification. One of these (Daniels' No. 10) is considerably larger than any of those seen by Prof. Cope, having a length of 31 mm. The other specimens in my hands are Daniels' Nos. 11, 20, 21, and U. S. Nat. Mus. Cat. No. 4366, the latter being a part of the Lacoe collection.

As before stated, Prof. Cope referred to this species the specimens described and figured by Newberry and Worthen in vol. iv of the *Geological Survey of Illinois*, p. 349, Figs. 13, 14. Of the correctness of the identification of Figure 14 there can be no doubt. As to Figure 13, Prof. Cope himself was in doubt, mainly because it represented a scale much larger than any other of the species in his hands. The scale before me which bears U. S. Nat. Mus. Cat. No. 4366, broken away slightly at the proximal end, has been nearly as long as the one represented by Newberry and Worthen's Figure 13, but is narrower, the length being 63 mm., the width 38 mm. The distal border is more convex than that of the figure. It has all the characteristics of the smaller specimens of *S. quincunciatus*, and it becomes more certain that the one figured by Newberry and Worthen belongs here. In this species the nutrient canals stream backward toward the posterior border, constantly anastomosing with one another, and in the middle region of the scale forming an irregular and fine areolation. Above and below the growth-centre there are a few very large cells, and similar cells

are continued backward, growing smaller to near the posterior border. It seems to me that Newberry and Worthen's Figures 13 and 14 present the characteristics of the scales of this species in a pretty satisfactory manner; although in Figure 13 the areolation is not small enough. Prof. Cope's figure of the species represents the concentric lines of growth near the posterior border entirely too conspicuous; although in his description he says that they are rarely present.

Prof. Cope has stated that one of the nodules in his hands contained two scales in mutual relation. A careful examination shows that there are three such scales present. I have before me a scale 50 mm. long taken from a modern *Ceratodus*, which in form and the general arrangement of the nutrient canals is strikingly like the large scale of *S. quincunciatus* above described. However, I find that in the living *Ceratodus* the canals do not give off so many branches, and that consequently the enclosed area or cells are much larger than in *Sagenodus*.

Sagenodus textilis Hay.

Sagenodus gurteianus Cope, Proc. Amer. Philos. Soc., xxxvi, p. 82, Pl. i, Fig. 9 (preoccupied by Cope, 1877); Williston, S. W., *Kansas Univ. Quart.*, viii, 1899, p. 177.

Sagenodus textilis, Hay, O. P., *Amer. Naturalist*, xxxiii, 1899, p. 786.

This, on careful examination of the type specimen, I regard as a very distinct species, and it is well represented in Cope's figure cited above. Under a lens no radiating striæ are seen anywhere. A trace of lines of growth is present at one of the angles, and from these I infer that the proximal extremity of the scale is that narrowed border which in Prof. Cope's figure is directed upward and toward the eft hand. No other specimens are known.

Rhizodopsis mazonius sp. nov.

This species is based on a single scale which bears the U. S. National Museum Catalogue, No. 4337. It belongs to the Lacoe collection and was obtained at Mazon creek, Ills. It was in Prof. Cope's hands and bears his numbers F, 65, F, 66, the nodule being split as usual into two portions. Prof. Cope has labeled the specimen "*Cœlacanthus* sp. Cope," but it does not belong to this genus and probably not to the family of Cœlacanthidæ. The

sculpture of the scale resembles closely that of *Rhizodopsis robustus*, as shown by Figure 3 of Plate xvi of Mr. A. Smith Woodward's *Catalogue of Fossil Fishes*, Part ii; and I place the species in that genus provisionally. The only reason I have for doubting the correctness of this assignment is the existence of a network of anastomosing lines throughout the denser portion of the scale, or something more than the proximal one-half of the area of the scale. This network is exceedingly irregular, like the cracks in dried mud, but nevertheless reminds much of the network of nutrient canals found in the scales of *Sagenodus*. In the scale before me these apparent canals are occupied by the white mineral which is so often found in fossils from this locality. It is not improbable that the bony substance of the scale has shrunken and cracked and the cracks been filled up with a foreign substance. If it shall prove that these are really nutrient canals the scale will represent apparently an undescribed genus close to *Sagenodus*.

The scale here described is ovate in form, being somewhat pointed at the proximal end. Its length is 25 mm, its breadth 14.3 mm. The proximal half has been osseous and rather thick, its thickness now, after the compression to which it has been subjected, being about equal to that of ordinary book paper.

The centre of growth or nucleus is located very close to the central part of the scale and the sculpture is disposed with reference to this nucleus. Concentric lines of growth appear on the lower surface of the osseous substance and on the underlying matrix. From the nucleus thread-like lines radiate to the proximal border of the scale and cover a broadly wedge-shaped area. Of these lines there are about ten in a millimetre. Similar lines, starting from the free border of the scale, converge toward the nucleus, but the outer ones, upper and lower respectively, pass above and below the nucleus and assume the position of concentric lines.

STREPSODUS HARDINGI (Dawson).

Rhizodus hardingi, Dawson, J. W., *Acadian Geology*, 1868 and 1878, p. 255, Fig. 77, a–d.

Strepsodus hardingi, Woodward, A. S., *Cat. Fossil Fishes*, ii, 1891, p. 353.

This is the only North American species which has up to this time been assigned to this genus. It was named and figured by

Dr. Dawson, as cited above, but there was practically no description presented. The figures represent two scales, a small one and a portion of a large one. They show the size and form, the existence of radiating and concentric lines, and near the centre an elongated mark of some kind.

From the Peter Redpath Museum, in Montreal, through the kind offices of Prof. Frank D. Adams, I have received two specimens of the scales of this fish, both of which were presented to the Museum by Dr. Dawson. Although evidently not the subjects of his figures, they may be accepted as authentic representatives of his species. Both are large scales, but they differ much in form. One of these, having a part of one side missing, has been almost circular, with a diameter of 38 mm.; the other is oval, with a long axis of 40 mm. and a short axis of 33 mm. The large scale figured by Dr. Dawson must also have been nearly circular, while the small one was ovate. We have here an illustration of the futility of relying much on the form and size of scales.

The scales before me appear to present their inner surfaces. The circular scale has an elongated depression, whose posterior end is placed very close to the centre of the scale. From this there diverge nearly straight rows of elevated points. What we have then seems to be merely a cast of the inner surface, the points being the fillings of the pits of that surface. Concentric lines occupy a large part of the surface, being most distinct anteriorly, very indistinct posteriorly. Some evidences of longitudinal striæ, or radii, are found along the anterior border, where the surface of the scale appears abraded. The substance of the oval scale is present. Its boss, not very distinctly shown, is in the centre of the scale. From it lines of small pits and low folds diverge in straight lines to the posterior border. At the border the folds are well shown. It seems probable that these folds and rows of pits represent the course taken by the furrows of the other side of the scale. In *S. arenosus*, next described, these furrows run forward and branch in a very irregular manner. The surface of the oval scale here described shows a fine fibrillation whose lines run in various directions, apparently without relation to the other markings. The circular scale is from the Horton beds of the Subcarboniferous at Horton, Nova Scotia; the oval scale is from Pictou, and probably from the same deposits.

STREPSODUS ARENOSUS sp. nov.

There has been placed in my hands by Dr. David White, of the United States Geological Survey, for identification, the imprint of the external surface of a scale of a species of the genus *Strepsodus*. This fossil was collected by Dr. White from a shale near the base of the Lower Carboniferous rocks, in the vicinity of Collier's Station, Blair county, Pa.

FIG. 3. Strepsodus arenosus.

The scale is somewhat imperfect, through the loss of a small portion of the distal, or free border. Nevertheless, enough is present to give us all the essential characters. The scale has had a length of about 28 mm. and a breadth of 21 mm. The proximal, or attached, end has been broadly rounded; the free end was also rounded, but probably less broadly. The most conspicuous feature of the ornamentation of the fossil is found in the system of furrows, which resemble a tree with its trunk and branches. These furrows, according to Mr. A. S. Woodward, are on the external surface of the scale. The main trunk is a furrow which began a little proximad of the centre of growth and a little less than one-third the length of the scale from its attached end. This, or a portion of it, would be represented on the other side of the scale by an elevation, or boss. At about the centre of the scale the main furrow begins to give off lateral branches in such a way that, like a deliquescent tree, it is soon lost. The smaller divisions of the branches were carried out to the free border of the scale.

The surface of the scale is everywhere covered by a fine, almost microscopic sculpture, which is produced by numerous elevated points. These are arranged in either concentric or radiating lines and often in both. There are about ten of these lines in a millimetre. On the upper and lower sides of the scale the concentric lines predominate; on the posterior portion of the scale the radiating lines are more conspicuous. These lines of minute elevations are also found in the furrows. Near the free border of the scale the elevations appear to have coalesced in rows, so as to make continuous longitudinal ridges.

The specific name has been suggested by the sculpture of the surface, which resembles grains of fine sand arranged closely together in rows.

STREPSODUS DAWSONI sp. nov.

Rhizodus lancifer, in part, Dawson, J. W., *Acadian Geology*, 1868 and 1878, p. 210, Fig. 56[b] (not *a*).

In his *Acadian Geology*, as cited above, first in 1868, Principal, afterwards Sir William, Dawson identified, with doubt, some teeth which had been found in the deposits of the coal-measures at Pictou, Nova Scotia, with similar teeth which had been described by Dr. J. S. Newberry from the coal-measures of Ohio. Found in the same deposits at Pictou were many scales, and these too were regarded as belonging to the same species. Dr. Newberry also had found some large scales in the deposits at Linton, Ohio, which furnished the teeth, and these scales, he thought, might have belonged to the animals which had borne the teeth. It is quite evident, however, that the scales found in the two localities were not the same; and it is far from certain that the teeth are not those of Batrachia. And even if the Acadian teeth are those of fishes, there is no proof that they and the scales belong to the same species or even genus. Hence, it appears to be better to allow the teeth to stand on their own merits and to give the scales a name of their own.

From the Peter Redpath Museum I have received also a scale, No. 3076, which has every appearance of being the one which furnished the figure published by Dr. Dawson. This scale belongs to the genus *Strepsodus*, as defined by Mr. A. Smith Woodward, and I give it the name of *Strepsodus dawsoni*.

This scale has almost the exact dimensions of Dr. Dawson's figure, although the upper, or rather the hinder, end is somewhat less rounded than indicated by the figure. The length is 19 mm., the extreme width 18 mm. As seems to be indicated by the ornamentation, the inner surface is exposed to view. Nearer the anterior than the posterior end is a small elongated boss, or protuberance, a characteristic of the genus. The surface of the scale behind this is marked by numerous little pits. Dr. Dawson's figure represents these pits as existing also in front of the boss, but I find none there. They appear to be arranged somewhat in rows, which radiate from the boss to the hinder edge of the scale. All around the scale, but less distinct on the anterior end, there is a rather wide border, which is occupied by undulating and concentric lines of growth. In this border there is, on one side, an interruption in the course of these lines, as though the scale had been crumpled. Dr. Dawson's

figure represents this. At the anterior end of this scale the border just referred to is crossed by numerous fine longitudinal striæ, or radii. At the posterior end of the scale are seen wider folds. These probably have something to do with the large radiating furrows which would be found on the other side.

With the few specimens on hand it is difficult to specify characters by means of which this species may be distinguished from *S. hardingi*. Were they both found in the same formation I would hesitate to separate them, but it is unlikely that the same species occurs in the Subcarboniferous and in the Coal-measures. Were the outer surfaces of the scales exposed we might possibly discover differential characters. So far as the specimens of the two species indicate, the boss of *S. hardingi* is placed nearer the centre of the scale than is that of *S. dawsoni*. I find on the surface of the latter species no such fibrillation as is seen on *S. hardingi*, but this may be due to the character of the preservation. *S. dawsoni* is a much smaller scale than any yet reported of *S. hardingi*, but we must not place too much reliance on this fact.

Cœlacanthus robustus Newb.

Cœlacanthus robustus, Newberry, J. S., *Proc. Acad. Nat. Sci. Phila.*, viii, 1856, p. 98; *Geol. Surv. Ohio*, Pal. i, Pt. 2, 1873, p. 341, Pl. xl, Figs. 2, 2a; *Pal. Fishes N. America*, 1890, p. 228; Huxley, T. H., *Mem. Geolog. Survey United Kingdom*, x, 1866, p. 14; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 406.

Rhabdoderma robustum, Reis, O. M., *Palæontographica*, xxxv, 1888, p. 71.

A single scale of this species has the U. S. Natural Museum's Catalogue No. 4336. It also bears Prof. Cope's number F, 37, and belongs to the Lacoe collection. Prof. Cope has labeled it "*Cœlacanthus* sp. Cope, Mazon creek, Illinois." It seems to me that it certainly belongs to *C. robustus* Newb. The species was originally described from specimens found in the coal measures at Linton, O. So far as I can judge, from a comparison of the Mazon creek specimen with the description and figure presented by Newberry, there is no important difference, unless it is that of size and proportions. The Mazon creek scale has a length of 23 mm. and an extreme width of 14 mm. Dr. Newberry's specimen figured had a length of 20 mm. and a width of 14 mm., being therefore

relatively a broader scale. It is also, as represented, slightly less drawn out at the free tip than in the scale before me; but such discrepancies are scarcely to be considered. The exposed portion of the scale is embellished with fine, closely crowded, thread-like lines, which starting from the tip run forward, diverge, give off branches, and remain of the same size. A little distance in front of the tip of the scale the lateral lines cease to branch, but those along the median line of the scale continue to do so. New lines also continue to start from the border of the scale as far forward as the lines continue. This uncovered portion of the scale also possesses a very narrow border of short, very fine lines, which are directed inwards at right angles to the edge of the scale. The ornamention of the portion of the scale overlapped by the adjacent scales is quite different from that described. The centre of growth of the scale is a very little in front of the centre of area of the scale, and the thread-like lines which have just been described come forward, in the midline of the scale, nearly to the growth-centre. On the covered part of the scale numerous delicate lines of growth are arranged concentrically around the centre of growth. Besides these, there is another system of extremely fine lines which start from the anterior border of the scale and from the lateral borders as far back as the scale is covered. They are directed backward and somewhat inward so as to cross the lines of growth at an angle, large in front of the growth-centre, small above and below it.

The ornamentation of this scale is decidedly different from that of *C. elegans* as represented by Mr. A. S. Woodward.[1] According to his figure there are only about forty-five thread-lines to be counted across the widest part of the area of the scale; while in that before me there are about eighty such lines. This difference harmonizes well with Newberry's figures of the scales of the two species and with his statement,[2] when speaking of *C. ornatus*, that the ornamentation of the latter is not only relatively, but absolutely coarser than that of *C. robustus*, in individuals ten times as large.

[1] *Cat. Fossil Fishes*, Pt. ii, Pl. xiv, Fig. 2a.

[2] *Geolog. Surv. Ohio*, Pal. i, p. 340.

ELONICHTHYS PELTIGERUS? Newberry. (Plate VII.)

Elonichthys peltigerus, Newberry, J. S., *Proc. Acad. Nat. Sci. Phila.*, 1856, p. 98; Woodward, A. S., *Cat. Foss. Fishes*, Pt. ii, 1891, p. 90.

Palæoniscus peltigerus, Newberry, J. S., *Geolog. Surv. Illinois*, ii, 1866, p. 17; *Geolog. Surv. Ohio*, ii, Pt. ii, 1873, p. 345, Pl. xxxviii, Figs. 1–1^b.

The illustrations of the above species of fossil fish presented by Dr. Newberry were all derived from the same specimen, one presumably, but not certainly, from the Carboniferous shales of Linton, Ohio. Mr. A. S. Woodward, as cited above, states that the type specimen is in the collection belonging to Columbia University, of New York; but a search for it, kindly permitted by Dr. Bashford Dean, has not rewarded me with a view of it. Dr. Newberry says that he has obtained specimens of the fish from various localities in Ohio, Indiana and Illinois, those from the last State being credited to Fulton county. With several specimens in his hands, he ought to have been able to avoid any serious errors in his statement of the specific characters. Nevertheless, it is unquestionable that some errors did creep into his description and figures; and if the fishes before me belong to his species there is involved a number of errors.

In my hands are specimens of a species of *Elonichthys* which were obtained at Mazon creek, Illinois, by Mr. Daniels. These are contained in iron-stone nodules and are nearly all somewhat imperfect. The best is one which has a length of 137 mm. In this specimen the head is badly crushed, the region in front of the dorsal fin is injured, the extreme tip of the tail is gone, and there is a piece broken from the body just below the front of the dorsal fin. All the fins are shown pretty satisfactorily. This has the collector's No. 1 on it. No. 2 shows a fish which has been badly macerated and crumpled, but the ornamentation of the scales is well displayed. No. 3 is a young fish 50 mm. long and well preserved. No. 4 is a much disturbed fish showing only some scales, the pectoral and caudal fins. No. 7 consists of only the upper lobe of the caudal fin, but it shows well the striated fulcra, the caudal scales and the caudal rays.

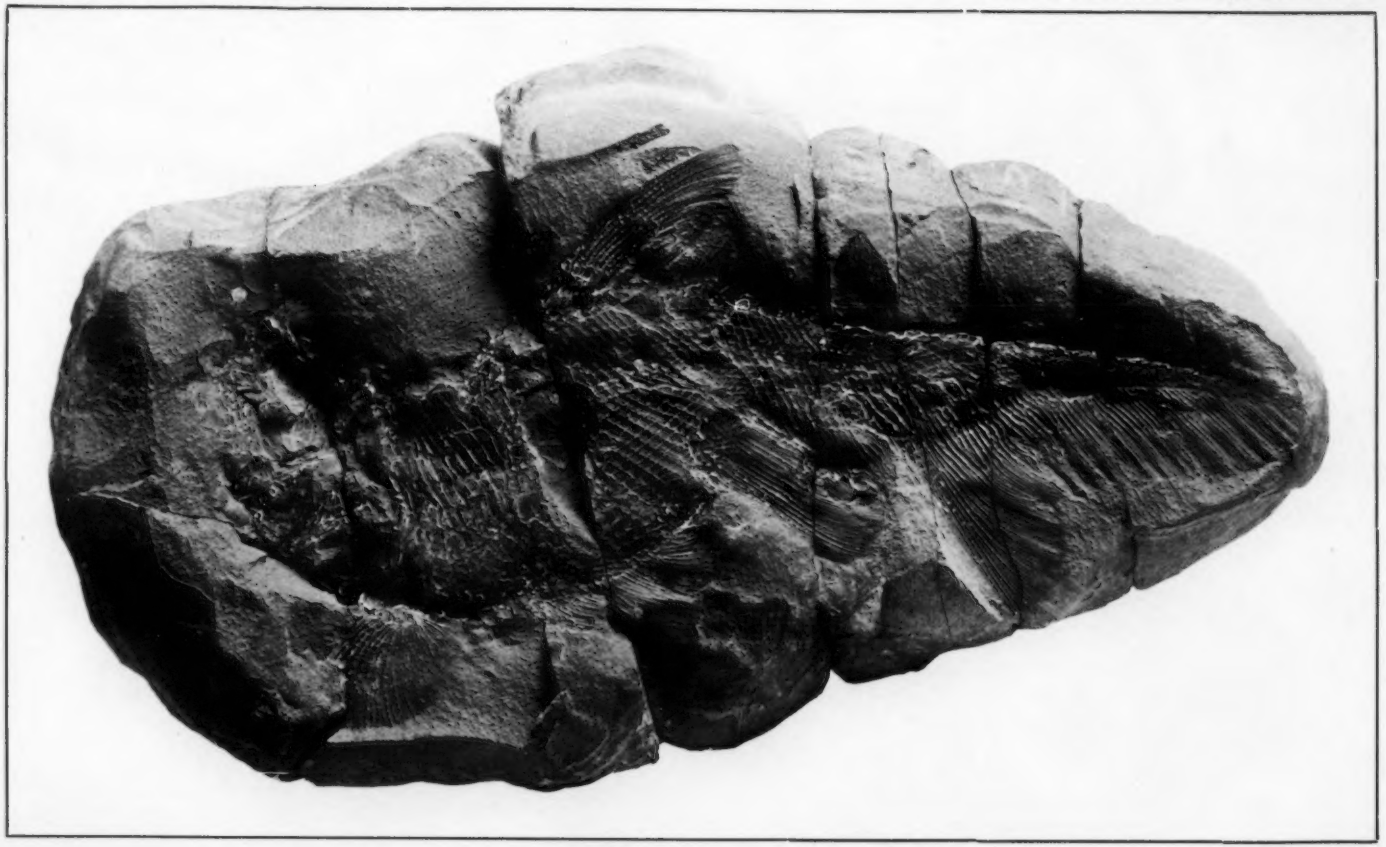
Besides this material, I have found in the collection of Columbia University another specimen evidently of the same species, from Mazon creek, Illinois, and this is labeled in Dr. Newberry's handwriting "*Palæoniscus peltigerus.*"

I have been in much doubt what disposition to make of this material. All the specimens show some important differences from the descriptions and figures of Dr. Newberry, and they may represent a distinct and undescribed species, but of this I cannot be sure. On the other hand, if it is identical with Newberry's species, the latter requires redescription, and an attempt to furnish this may result in basing a description on a species distinct from that described by Dr. Newberry.

The striking peculiarity of the type of Dr. Newberry's *E. peltigerus* and the one which suggested the specific name was the possession of a series of enlarged scales along the midline of the back, both in front of the dorsal fin and behind it. Those in front of the fin are said to be four times as large as the ordinary scales, and are so figured. Those behind the fin are said to become modified posteriorly into the strong fulcra of the tail, but Dr. Newberry's figures do not represent any fulcra present. I find such enlarged scales in only one of the specimens in my hands, that of one of the halves of nodule No. 3, which bears the impression of a little fish 50 mm. long. In all the other specimens they are missing, even when the preservation is such that they might be expected. Evidently the opportunity of seeing them depends, to a great extent, on the way in which the nodule splits.

These scales, as shown in the specimen referred to, begin close behind the head and continue backward nearly to the fin, but there is a brief interruption, probably accidental, about three-fourths of the way back. Just in front of the fin they again appear and, as shown especially in the Columbia University specimen, they change gradually into fin fulcra. This row of scales extends further forward than that described by Dr. Newberry, are in greater number and of different form; but all these differences may not be important. Immediately behind the dorsal fin I find no enlarged scales in any of the specimens. The fulcra begin as small, pointed scales and gradually enlarge.

Excepting the enlarged scales mentioned above, Dr. Newberry neither described nor figured any others peculiar in any way. Those immediately behind the shoulder girdle and on the flanks are all represented as being about as high as long. But in all of the specimens in my hands which are well enough preserved I find that the scales in several perpendicular rows just behind the shoulder girdle are twice as high as long. In case Dr. Newberry's type specimen



ELONICHTHYS PELTIGERUS HYPSILEPIS.

had such scales in this region as he has represented, it seems probable that those in my hands belong to a distinct species. These high scales gradually become reduced in height, so that those below the dorsal fin are about as high as long. The specimen 50 mm. long does not show so well the height of the anterior scales, and it is quite probable that the height increases with the size of the fish. They are shown in the Columbia University specimen. The type of Dr. Newberry's species was five inches long and ought to have revealed these high scales.

The caudal fin of the present specimens is very different from that represented in Dr. Newberry's figures, but this is probably due to the imperfection of his materials. In his figures the tail is relatively short and single-lobed, while the scaly extension of the body beyond the beginning of the fin is less than one-fourth of the length of the fish. In my material the caudal fin is fully one-third the total length of the fish, is deeply forked and has the prolongation of the body covered with pointed scales carried out apparently to its very tip. I count in the longest specimen seventy-five rays, in the Columbia University specimen about sixty, but some are probably missing in the case of both fishes. Along the upper lobe of the tail are numerous striated fulcra. These diminish in height each way from the middle of the lobe.

The dorsal fin contains about twenty-five rays. I count a few more in the large specimen, a few less in that belonging to Columbia University. The fin base equals about one-seventh of the length of the fish, the height is somewhat greater. There were about twenty-five ventral rays, possibly a few more. Dr. Newberry states that in his specimen there were only ten pectoral rays, but undoubtedly it was defective. I count easily twenty rays in the large specimen, in which the fin is well displayed. The anal fin contains about forty rays, and its length was about equal to that of the dorsal.

I do not find that the ornamentation of the scales is different from that described by Newberry. Of the scales there seem to be eight rows above the lateral line and fourteen rows below it.

The body appears to have been somewhat elevated immediately under the dorsal fin, the latter being thus lifted somewhat. The sides of this elevation are covered with two rows, an upper and a lower, of narrow, rather long scales, which are directed parallel with the fin rays. The lower jaw, as shown by specimen No. 2

of Mr. Daniels' collection, is occupied by a row of closely set sharp teeth. The branchiostegals are short and broad, the number not determinable. The mouth was large, the eyes large and placed near the end of the head.

In case it shall be proved that the specimens described above belong to a species distinct from that of Dr. Newberry, I suggest that they be called *Elonichthys hypsilepis*, with the large specimen of the Daniels collection as type, that in Columbia University as co-type.

It seems highly probable that the fish mentioned by Newberry and Worthen in volume iv of the *Geological Survey of Illinois*, p. 348, 1870, under the name *Amblypterus macropterus?* Agassiz, may in reality have belonged to the same species as those herein described. It is regarded by Mr. A. S. Woodward as being an *Elonichthys*.

Amphibamus grandiceps Cope.

Amphibamus grandiceps Cope, *Proc. Acad. Nat. Sci. Phila.*, 1865, p. 134; *Geol. Surv. Illinois*, ii, 1866, p. 135, Pl. xxxii, Fig. 8, and woodcut p. 136; Trans. Amer. Philos. Soc., (2) xiv, 1869, p. 8; Fritsch, A., *Fauna Gaskohle*, i, 1880, p. 93, Fig. 44; Miller, S. A., *N. Amer. Geol. and Pal.*, 1889, p. 618, Fig. 1178; Dana, J. D., *Man. Geol.*, 4th ed., 1896, p. 683, Fig. 1108.

In the collection belonging to Mr. Daniels there is a split nodule from Mazon creek, which contains the remains of a specimen of *Amphibamus grandiceps* Cope. The fossil has been somewhat damaged by fractures and a small portion is missing. Furthermore, as in the case of the original, the bones have been replaced by a soft white mineral, so that it has been found necessary in places to remove this and take wax impressions. Notwithstanding the lack of perfection in the fossil, it presents so many interesting features that it seems desirable that it shall be described; especially since it is, so far as I am aware, the only specimen of the species which has been found since the discovery of the original.

The entire length of this ancient salamander is 62 mm. The head is 15 mm. long and has a width almost exactly the same. The tail of the animal has been short, not exceeding probably 12 mm. Prof. Cope has represented the hinder limbs and portions of the anterior limbs. The whole hinder limb has had a length of 17 mm.; the fore limb, so far as I can determine, a length of 13 mm.

One important character exhibited in the specimen before me is the presence of ribs. The original specimen appears not to have exhibited these; and Prof. Cope concluded that they were really not present in the animal, and on this character more especially founded for it the order Xenorhachia, a group which he later abandoned. The ribs of *Amphibamus* are very slender, rather long and curved, expanded at the proximal end, and with the distinct appearance of having been double-headed. In this respect it differs markedly from *Branchiosaurus*, as described and figured by Fritsch, in which the ribs are short, stout, straight and single-headed. The number of pairs of ribs I am not able to determine with exactness. They are seen to approach to within 7 mm. of the head and to within less than this distance of what I regard as the sacral region. I make out the existence of at least twelve pairs, and there were evidently others near the head and probably still others closer to the sacrum. There are also traces of what appear to be one or two caudal ribs.

I find it impossible to determine exactly either the number or the form of the vertebræ, or the extent to which they are ossified. To *Branchiosaurus* Fritsch has attributed twenty presacral vertebræ, all of which possessed ribs except the most anterior. Prof. Cope thought that *Amphibamus* possessed probably thirteen. Basing my judgment on the apparent length of a few centra, I think that the number will fall a little short of twenty. The neural spines must have been very short. I cannot determine the presence of distinct processes for the attachment of the ribs. The vertebral, column as a whole was slender, not broad as that of *Branchiosaurus*.

The head, though about as broad as long, has its greatest breadth far behind, while the outlines converge with a gentle curve to the snout, which is thus not so broadly rounded as in many of the related forms. The bones of the head were probably ornamented with a raised network of lines, enclosing pits. Prof. Cope regarded the head as being squamous. Many of the sutures between the bones are indistinct. The premaxillaries are undoubtedly separate. They appear to have each a short and broad ascending process. Exterior to this lies the exterior nares, bounded behind by the large and separate nasals, which meet along the midline. Prof. Cope indicated with doubt a suture crossing the interorbital space between its anterior and middle thirds, and another between the middle and

posterior thirds. While the specimen in my hands does not testify on these points as distinctly as one might wish, it seems probable that Prof. Cope was correct. Between these sutures would lie the frontals, probably, but not certainly, distinct from each other. In front of each eye is a curved prefrontal. Behind the frontals come the parietals, probably separated from each other by sutures. Near the coronal suture is seen the circular parietal foramen. Behind the eye lies a relatively large bone, which probably represents both the postfrontal and postorbital. Jugal, supratemporal, squamosal and epiotic appear to be clearly distinguishable, the latter extending prominently backward. The upper eyelid appears to have been strengthened by a pavement of bony plates over the eyeball, and near the free border this seems to have been produced into a kind of horn. The eyes must have been very large. Prof. Cope has represented a row of fourteen plates over the eyeball, which he regarded as bordering the lid. It is more probable that they are sclerotic plates. I do not find them. That author also describes and figures a whorl of scales on each side of the posterior region of the skull. I have seen no traces of these. The jaws were provided with numerous small conical teeth, but they are not in such a con dition that I can say more about them.

The left forearm is apparently in its proper place. The humerus and one bone of the forearm are present. These are followed by numerous small bones, considerably disturbed, which I take to be those of the hand. What appears to be a distal phalangeal bone is relatively large and ends in a point. I cannot determine the number of digits. The head of the humerus lies against and laterad of the impression of a bone which I regard as the scapula. It is 4 mm. long and one-half as wide and with a border which is concave on the side next to the head of the humerus. This bone approaches closely the notch in the back of the skull.

Lying behind the angle of the jaw and running parallel with the body is a slender bone apparently consisting of two segments; this I take to be a part of the hyoidean apparatus.

The hinder limb is tolerably well preserved. The tibia and fibula are about two-thirds as long as the femur and they have a wide space between their shafts. Their distal ends are considerably expanded. There were five digits. No tarsal bones are seen; the first digit seems to have been very short, the next one very long. The terminal phalange of this ends in a sharp point. The terminal

segments of the other digits are not shown. The head of the femur comes up against a bone which undoubtedly belongs to the pelvis. Where the head of the femur touches it this bone is thick and solid; further behind it appears to have been a very slender, slightly curved rod. On the ventral surface of the animal, immediately in front of the sacral region, I find a quadrate patch of granulations, which seem to represent the impression of some bone pitted like those of the head. This may indicate a broad pubis or it may be produced by the bony armor of the skin in that region. Elsewhere I find numerous evidences of the existence of dermal defenses. None of these probably belonged to the upper region of the body. They apparently consisted of small bony plates which were arranged in rows. These began at or near the midline below and swept outward and backward to the sides. In one place I find ten of these rows in a width of two millimetres.

As to the relationship of this animal, it seems to me that while there are many structures yet unknown, such as the arrangement of the bones and teeth of the roof of the mouth, the sternal apparatus, and the condition of the vertebræ, it is closer to such forms as *Hylonomus* than to *Branchiosaurus*. The form of the head is different from *Branchiosaurus;* likewise the ribs and the limb bones.

NATIVE TRIBES OF WESTERN AUSTRALIA.

BY R. H. MATHEWS, L.S.

(*Read March 16, 1900.*)

Western Australia contains an estimated area of 978,299 square miles, or, inclusive of the contiguous islands, about 1,057,250 square miles, being about eight times the size of Great Britain. It is the largest of all the colonies of Australia, containing more than a third of the entire area of that continent. In the southwest coastal districts there is much land suitable for farming operations, and farther north there are extensive grassy downs, capable of depasturing immense numbers of sheep and cattle. Considerable areas are gold-producing, chief among which may be mentioned Coolgardie, Cue, Marble Bar and Kimberley—comparable in extent to some prominent European kingdoms. By far the greater portion of the colony, however, consists of vast arid tracts of sand and scrub, which is practically a desert.

In the present preliminary paper it is intended to give a brief outline of the social organization, rites and customs of the native tribes sparsely distributed over the whole of that portion of western Australia lying to the north of the twenty-eighth parallel of south latitude. Compared to the size of the territory occupied the number of the aboriginal inhabitants is insignificant.

On the Murchison, Greenough, Sanford, Roderick, Wooramel, Gascoyne and Lyons rivers the several native tribes are each divided into four sections, called Buljerry, Kiemarra, Boorong and Boogarloo. The intermarriage of these divisions, and the sections to which the resulting offspring belong, will be readily understood when arranged in tabular form, as under:

Husband.	*Wife.*	*Offspring.*
Buljerry	Boorong	Boogarloo
Kiemarra	Boogarloo	Boorong
Boorong	Buljerry	Kiemarra
Boogarloo	Kiemarra	Buljerry

These sectional names, with some modifications, are found among the natives at Weld Spring, Bonython Creek, Lake Throssell, Elder Creek, Glen Cumming, and extend eastward into South Australia, where a similar organization exists among the Andikarina and Arrinda tribes, particularized by me in previous publications.

If we travel northward from the Murchison, Gascoyne and other streams above mentioned, we discover that the tribes occupying the Ashburton, Fortescue, Yule, Shaw, De Grey and Oakover rivers are likewise divided into four sections, the names of which are Butcharrie, Kurrimurra, Burronga and Banaka, being simply variations of the nomenclature tabulated in this paper, Banaka taking the place of Boogarloo. These sections reach easterly into the northern territory of South Australia.

Proceeding still farther to the northward from the Oakover to the Fitzroy river, the four sections are known as Baljarra, Boorungo, Kimbera and Bannicka, the men of one section marrying the women of another in a certain fixed rotation. In all the tribes referred to in this paper there are aggregates of totems attached to each section or pair of sections, and descent of the children is counted through the mothers.

In the northeastern corner of western Australia, comprising the region watered by the Ord River and its tributaries, Sturt Creek, Margaret river and the Upper Fitzroy, are a number of native tribes, particulars of whose divisions and the limits of their territory are described in papers which I have communicated to different learned societies.

In all the country dealt with in the present article, with the exception of a strip along the western coast from about Geraldton to Onslow, all the youths are circumcised. Some time after their recovery they must submit to a further mutilation, consisting of splitting open the urethral canal from a point a little way from the scrotum almost to the glans, but leaving the latter intact, the incision being about two inches in length. In some tribes the glans is also split, the cut being carried right into the urinary orifice. After a man recovers from the effects of splitting the penis he is allotted a boy who has not yet been operated upon. This youth is a brother of the woman whom the man is entitled to claim as his wife. The boy is used for purposes of masturbation and sodomy, and constantly accompanies the man.

The natives who inhabit the barren desert country are much inferior to the coast tribes, both in personal appearance and in their weapons and utensils. Their mode of camping at night during the cold months of the winter is as follows: They scoop out a circular depression in the sand, about eighteen inches deep, the diameter varying with the number of individuals who are to use it. In this depression they light a fire, and gradually replace the sand they have scooped out until it is all sufficiently heated. At bedtime each person scrapes a trench in the warm sand and lies down without any clothing, letting the loose sand fall in around his body, except the face. A man, with his wives and children, would perhaps occupy one of these sleeping places, several young men another, some unmarried or old women another, and so on. It not unfrequently happens that pebbles are mixed with the sand, and these retain the heat for a longer time. Although not sufficiently hot to burn the skin of the sleepers, yet on lying against a person's body for a long time they raise blisters, which sometimes become sores, especially on the tender skin of children. No fire is kept alight during the night, but on emerging from their lairs in the morning fires are lit to cook any animal food they may have on hand.

ERRATA.

Papers on "The Specializations of the Lepidopterous Wing: The Parnassi-Papilionidæ," by A. Radcliffe Grote, Vol. xxxviii, No. 159:

Page 16, line 12, *for* IV_2 *read* IV_3.

Page 16, line 21, *for* IV_2 *read* IV_1.

Page 20, line 10, *for* IV *read* IV_2.

Page 37, line 13, *for* monophyllism *read* monophyletism.